Inferior Venacaval Filters
Valuable vs. Dangerous
Valuable – Annie Kulungowski

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History of Vena Cava Filters

- **Virchow-1846** - Proposes PE originate from veins of lower extremity
- **Trousseau-1868**
  - Perhaps by placing barrier in IVC → PE prevented
History of Vena Cava Filters

- 1893 - Bottini - Ligates IVC
- 1950 - Oschner popularizes Bottini’s technique
- 1959 - Moretz - External clipping of IVC

History of IVC filters

- 1960s-Adams-DeWeese-Miles invent clips
- 1967-Mobin-Uddin Filter
History of IVC Filters

- 1973 Dr. Greenfield introduces the 1st IVC filter
A new intracaval filter permitting continued flow and resolution of emboli

Incidence of DVT/PE

- **Venous thromboembolism**
  - 104 to 117/100,000 persons in USA (0.1%)

- **Pulmonary embolism**
  - 275,000 cases
  - 50,000 deaths annually
  - 3rd leading cause of death in USA

- **Anticoagulation first line treatment**
Indications for IVC filter

- **Contraindication to anticoagulation**
  - Recent major operation
  - Intracranial hemorrhage
  - Coagulopathy
  - Major risk of falling

- **Complication of anticoagulation**
  - Bleeding
  - Failure of anticoagulation
    - DVT or PE despite tx
  - Large free-floating clot loosely attached to IVC wall
  - Limited cardiopulmonary reserve

Types of Vena Cava Filters

- **Permanent**
  - Greenfield (stainless steel, titanium)
  - Greenfield
  - Bird’s Nest
  - Nitinol
  - Vena Tech
  - TrapEase
  - Bard nonrecovery

- **Retrievable**
  - Gunter Tulip
  - Bard Recovery
  - OptEase
PREPIC Study

- Multicenter, randomized trial, France
- 400 patients all with proximal DVT

Outcome
- recurrent VTE
- Death
- Bleeding

12 days and 2 years

# Base-Line Characteristics of Study Patients-PREPIC

<table>
<thead>
<tr>
<th></th>
<th>Filter N=200</th>
<th>No filter N=200</th>
<th>LMWH N=195</th>
<th>Unfrac Hep N=205</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>73</td>
<td>72</td>
<td>73</td>
<td>72</td>
</tr>
<tr>
<td>Male</td>
<td>92</td>
<td>98</td>
<td>93</td>
<td>97</td>
</tr>
<tr>
<td>Hx of prior VTE</td>
<td>70</td>
<td>71</td>
<td>70</td>
<td>71</td>
</tr>
<tr>
<td>Card/Resp</td>
<td>47</td>
<td>39</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td>Surgery last 60 d</td>
<td>17</td>
<td>26</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Cancer</td>
<td>32</td>
<td>24</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>PE</td>
<td>102</td>
<td>95</td>
<td>92</td>
<td>105</td>
</tr>
</tbody>
</table>
## End Points at 12 Days for Filter vs. No Filter

<table>
<thead>
<tr>
<th>End Point</th>
<th>Filter</th>
<th>No Filter</th>
<th>Odds Ratio</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Symptomatic</td>
<td>2 (1.1)</td>
<td>5</td>
<td></td>
<td>0.22</td>
</tr>
<tr>
<td>- Asymptomatic</td>
<td>0</td>
<td>4</td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>- All</td>
<td>2 (1.1)</td>
<td>9 (4.8)</td>
<td>0.22</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Major Bleeding</strong></td>
<td>9 (4.5)</td>
<td>6 (3)</td>
<td>1.49</td>
<td>0.44</td>
</tr>
<tr>
<td><strong>Death</strong></td>
<td>5 (2.5)</td>
<td>5 (2.5)</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>
## End Points at 2 years for Filter vs. No Filter

<table>
<thead>
<tr>
<th>Event</th>
<th>Filter</th>
<th>No Filter</th>
<th>OR</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>6 (3.5)</td>
<td>12 (6.3)</td>
<td>0.50</td>
<td>0.16</td>
</tr>
<tr>
<td>Recurrent DVT</td>
<td>37 (20.8)</td>
<td>21 (11.6)</td>
<td>1.87</td>
<td>0.02</td>
</tr>
<tr>
<td>Bleeding</td>
<td>17 (8.8)</td>
<td>22 (11.8)</td>
<td>0.77</td>
<td>0.41</td>
</tr>
<tr>
<td>Death</td>
<td>43 (21.6)</td>
<td>40 (20.1)</td>
<td>1.10</td>
<td>0.65</td>
</tr>
</tbody>
</table>
Eight-Year Follow Up PREPIC

- 400 patients with proximal DVT +/-PE
- 8 years 201 (50.3%) died

## Eight Year Follow-Up PREPIC

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Filter n=200</th>
<th>No Filter N=200</th>
<th>Hazard Ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic PE-nonfatal</td>
<td>9 (6.2)</td>
<td>24 (15.1)</td>
<td>0.37</td>
<td>.008</td>
</tr>
<tr>
<td>-fatal</td>
<td>7</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptomatic recurrent DVT</td>
<td>57 (35.7)</td>
<td>41 (27.5)</td>
<td>1.52</td>
<td>.042</td>
</tr>
<tr>
<td>Symptomatic VTE</td>
<td>58 (36.4)</td>
<td>55 (35.4)</td>
<td>1.12</td>
<td>0.54</td>
</tr>
<tr>
<td>Postthrombotic syndrome</td>
<td>109 (70.3)</td>
<td>107 (69.7)</td>
<td>0.87</td>
<td>0.30</td>
</tr>
<tr>
<td>Death</td>
<td>98 (48.1)</td>
<td>103 (51)</td>
<td>0.97</td>
<td>0.83</td>
</tr>
<tr>
<td>Major Bleeding</td>
<td>26 (15.4)</td>
<td>31 (18.5)</td>
<td>0.84</td>
<td>0.52</td>
</tr>
</tbody>
</table>
Risk Stratification Based on PREPIC Follow-Up

**Predictors of Death**
- Age - hazard ratio 1.60
- Cancer - hazard ratio 2.08
- Cardiovascular/Respiratory Insufficiency - hazard ratio 1.79
Retrievable Vena Caval Filters

- 2004 FDA approved the use of retrievable VCF
- Avoid the long-term complication of permanent devices
  - Recurrent DVT
- Transient medical conditions
  - Pregnancy
  - Trauma
  - Immobility
  - Obesity
  - Surgery
Retrievable Vena Cava Filter

- Prospective cohort study
- 220 patients ALN (retrievable) filter placed
- Age 71
- BMI 26
- Hx of VTE 43%

Indications for R-VCF

- Obligation to stop anti-coagulation therapy due to surgery, trauma, invasive procedure (38%)
- Contraindication to anticoagulation (27%)
- Temporary Bleeding Event (22%)
- Recurrent DVT on anticoagulation (11%)
Retrievable Vena Cava Filter

<table>
<thead>
<tr>
<th>Table 3—Clinical Events During Filter Implantation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events</td>
</tr>
<tr>
<td>Number of days of filter implantation,</td>
</tr>
<tr>
<td>median (Q1–Q3)</td>
</tr>
<tr>
<td>Immediate complication, No./total (%)</td>
</tr>
<tr>
<td>Filter tilting</td>
</tr>
<tr>
<td>Puncture site hematoma</td>
</tr>
<tr>
<td>Filter migration</td>
</tr>
<tr>
<td>Infection</td>
</tr>
<tr>
<td>Other†</td>
</tr>
<tr>
<td>Venous thromboembolic event</td>
</tr>
<tr>
<td>At least one event, No./total (%)‡</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
</tr>
<tr>
<td>DVT</td>
</tr>
<tr>
<td>Proximal DVT</td>
</tr>
<tr>
<td>Distal DVT</td>
</tr>
<tr>
<td>Upper-limb DVT</td>
</tr>
<tr>
<td>Event associated with filter thrombosis</td>
</tr>
<tr>
<td>Number of days between filter placement and first event, median (range)</td>
</tr>
<tr>
<td>Death, No./total (%)</td>
</tr>
<tr>
<td>Cause of death</td>
</tr>
<tr>
<td>Cancer</td>
</tr>
<tr>
<td>Bleeding</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
</tr>
<tr>
<td>Ischemic stroke</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Number of days between filter placement and death, median (range)</td>
</tr>
</tbody>
</table>
# Filter Retrieval

<table>
<thead>
<tr>
<th>Filter Retrieval</th>
<th>55/217 (25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days between insertion and retrieval</td>
<td>51 (6-352)</td>
</tr>
<tr>
<td>Clinical Events After Retrieval</td>
<td>1/55 (1.8%)</td>
</tr>
<tr>
<td>- VTE</td>
<td>1/55 (1.8%)</td>
</tr>
<tr>
<td>- Death</td>
<td>1/55 (1.8%)</td>
</tr>
</tbody>
</table>
Postoperative Pulmonary Embolism

- Rate of DVT general surgery patients not on prophylaxis is 15-30%  
- Fatal PE 0.2-1%
- Surgical Care Improvement Project
  - SSI
  - adverse cardiac outcomes
  - postoperative pneumonia
  - DVT
## Postoperative PE: Timing, Diagnosis, Treatment, and Outcomes

- 115 patients with PE
- Timing of PE 109/115

<table>
<thead>
<tr>
<th>Age</th>
<th># of patients</th>
<th>surgery to diagnosis of PE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>11</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>40-60</td>
<td>44</td>
<td>11.2</td>
<td>.02</td>
</tr>
<tr>
<td>&gt;60</td>
<td>54</td>
<td>6.7</td>
<td></td>
</tr>
</tbody>
</table>

IVC Filters and Subgroups of Surgical Patients

- Trauma
- Bariatric
- Orthopedic
- Neurosurgery
- Oncology
Timing of Pulmonary Emboli after Trauma: Implications for Retrievable Vena Cava Filters

- Multicenter retrospective chart review 2001-2004
- 146 patients with postinjury PE
- Mean age 45
- Diagnosis-CT, Angiogram, Autopsy, Clinical

Timing of PE After Trauma

Table 1: Timing of Postinjury Pulmonary Emboli Stratified by Week Intervals

<table>
<thead>
<tr>
<th>PE Occurrence</th>
<th>Frequency (n)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7 days</td>
<td>79</td>
<td>54.1</td>
</tr>
<tr>
<td>7–14 days</td>
<td>43</td>
<td>29.4</td>
</tr>
<tr>
<td>15–21 days</td>
<td>8</td>
<td>5.5</td>
</tr>
<tr>
<td>22–28 days</td>
<td>8</td>
<td>5.5</td>
</tr>
<tr>
<td>&gt;28 days</td>
<td>8</td>
<td>5.5</td>
</tr>
</tbody>
</table>

- 11% of patients had PE >21 days
- Mortality-17.8% (n=26)
- PE cause of death in 85% (22)
- Of the deaths attributable to PE→2 late, day 21 & 43
Extended Interval for R-VCF is Safe

- 83 patients-R-VCF

Indications
- Prophylaxis in trauma
- High risk surgical patients
- Prevention with contraindication to anticoag

Filter removal criteria
- Discharged for 30 days
- Fully recovered from injury
- Stable on therapeutic anticoag for 2 weeks
- Pre and post cavagram to eval for thrombus

Extended Interval for R-VCF is Safe

- Filter retrieval attempted in 54 (65%)
  - Failed in 6 due to tilt, SVC thrombosis
  - Complication- one patient, fractured strut
- Median 142 days (17-475)
- All patients seen 4 weeks post retrieval
  - None had filter-related complications
  - No post-insertion or post-retrieval PE’s
Obesity and VTE

- Obesity-independent risk factor for DVT, fatal and nonfatal PE
- PE is leading cause of death bariatrics
- High risk
  - BMI > 50
  - Heart failure
  - Hx of VTE
  - Pelvic Surgery

Obesity and VTE

General Recommendations for Prevention

- Identify high risk
- All should receive pre and post op anticoagulation
- High risk patients
  - IVC filter
  - Intraoperative heparin infusion
  - 3 months of coumadin

VTE and Orthopedic Patients

- Fatal PE occurs in 5%
  - Not anticoagulated
- 5607 enrolled undergoing hip and knee surgery
- VTE 2.7% (150)
- PE 1.1% (56)
- Most common post-surgical complication
Neurosurgery Patients and VTE

- 175 patients with VTE, CNS cancer or ICH
- Filters 136
- Anticoagulants only 39
- 128 patients died

Neurosurgery Patients and VTE

- Median survival filter group 21 wks
- No filter survival 11 weeks
- Filter group 28% reduction of risk of death compared to anticoag group
- HR=0.72 and P=0.18
Safety of the Greenfield Filter

- Access site thrombosis 1-3%
- Late PE 4%, Fatal PE 0.7%
- Migration/Tilt 5%
- IVC thrombosis 3.6%
- Filter deformation/fracture 2%
- Postphlebitic 45%
- Mortality 0.1%

Safety of Retrievable Filter

- 284 patients R-VCF
- Filter removed 144/159 (91%)
  - Only one required surgery
- Unable to be removed in 14 (9%)

Complications of Insertion
- Manipulation error, mechanism defect, hematoma, site thrombosis 1%

How to prevent VTE Disease

- Mechanical prophylaxis
- Pharmacologic prophylaxis
- Early mobilization
- Identify patients at higher than average risk
  - IVC filter
Future of IVC Filters

- Trial comparing patients who have failed anticoagulation/contraindication
  - IVC filter vs. No filter
- Long term trial comparing efficacy of P-VCF vs. R-VCF
- Study comparing the different type of R-VCF→SE, safety, prevention PE, mortality
References