When Should Inferior Vena Cava Filters (IVC) be Utilized and When Not?

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Disclosures

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• Armand Trousseau first proposed IVC interruption for the treatment of PE in 1865.
• IVC interruption with surgical ligation was first performed in 1893.
• Several surgical approaches were used up until the 1960s.
• Mid 1940s: Ochsner, DeBakey, and O’Neal performed IVC ligation procedures to prevent pulmonary emboli from the legs and pelvis.

• This method was associated with:
  • High operative mortality rate (14%)
  • Recurrent PE (6%)
  • Chronic venous stasis (33%)
GREENFIELD FILTER (1973)

- The next advance came in 1973, with the Kim-Ray Greenfield filter.
- The Greenfield filter became the device by which other devices are compared.
# Types of inferior vena cava filters

<table>
<thead>
<tr>
<th></th>
<th>Maximum IVC diameter (mm)</th>
<th>Manufacturer</th>
<th>Required sheath size (O.D.)*</th>
<th>Insertion sites</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Permanent (nonretrievable)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titanium Greenfield</td>
<td>26</td>
<td>Boston Scientific</td>
<td>12 Fr</td>
<td>Jugular, femoral</td>
<td>Titanium</td>
</tr>
<tr>
<td>Over the Wire Greenfield</td>
<td>28</td>
<td>Boston Scientific</td>
<td>12 Fr</td>
<td>Jugular, femoral</td>
<td>316 stainless steel</td>
</tr>
<tr>
<td>Vena Tech LP</td>
<td>26</td>
<td>B. Braun Medical</td>
<td>9 Fr</td>
<td>Jugular, femoral</td>
<td>Phynox§</td>
</tr>
<tr>
<td>Vena Tech LGM</td>
<td>28</td>
<td>B. Braun Medical</td>
<td>12 Fr</td>
<td>Jugular/femoral single system</td>
<td>Phynox§</td>
</tr>
<tr>
<td>Simon Nitinol Filter (SNF)</td>
<td>26</td>
<td>Bard</td>
<td>9 Fr</td>
<td>Jugular, femoral, subclavian, antecubital</td>
<td>Nitinol (Ni-Ti)</td>
</tr>
<tr>
<td>TrapEase</td>
<td>30</td>
<td>Cordis (J&amp;J)</td>
<td>6 Fr</td>
<td>Jugular, femoral, antecubital</td>
<td>Eligiloy¶</td>
</tr>
<tr>
<td>Gianturco-Rashkind Bird’s nest</td>
<td>40</td>
<td>Cook</td>
<td>12 Fr</td>
<td>Jugular, femoral</td>
<td>304 stainless steel</td>
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<tr>
<td><strong>Optional (permanent or retrievable)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OptiBase</td>
<td>30</td>
<td>Cordis (J&amp;J)</td>
<td>6 Fr</td>
<td>Jugular, femoral, antecubital</td>
<td>Eligiloy¶</td>
</tr>
<tr>
<td>Gunther tulip</td>
<td>30</td>
<td>Cook</td>
<td>8.5 Fr</td>
<td>Jugular, femoral</td>
<td>Conchrome§</td>
</tr>
<tr>
<td>Cook Cellect</td>
<td>30</td>
<td>Cook</td>
<td>7 Fr (1J), 8.5 Fr (F)</td>
<td>Jugular, femoral, UniSat</td>
<td>Conchrome*</td>
</tr>
<tr>
<td>Option</td>
<td>30</td>
<td>Argon Medical</td>
<td>8.5 Fr</td>
<td>Jugular, femoral</td>
<td>Nitinol (Ni-Ti)</td>
</tr>
<tr>
<td>ALN filter</td>
<td>32</td>
<td>ALN International</td>
<td>7 Fr</td>
<td>Jugular, femoral, basilic</td>
<td>316 stainless steel</td>
</tr>
<tr>
<td>Crux filter</td>
<td>28</td>
<td>Volcano</td>
<td>9 Fr</td>
<td>Jugular, femoral</td>
<td>Nitinol (Ni-Ti)</td>
</tr>
<tr>
<td>Denali</td>
<td>28</td>
<td>Bard</td>
<td>8.4 Fr Δ</td>
<td>Jugular, femoral</td>
<td>Nitinol (Ni-Ti)</td>
</tr>
</tbody>
</table>
The “Ideal” IVC Filter

- Non-thrombogenic
- Biocompatible
- Infinite implant lifetime
- High filtering efficiency
- No impedance of flow
- Secure fixation within IVC
- Low access site thrombosis

- Ease of percutaneous insertion
  - Small caliber delivery system
  - Release mechanism simple and controlled
  - Amenable to repositioning
- MR imaging compatibility
- Low cost
- Retrievability
Adjusted probability of **therapeutic** IVC Filter Placement

42% increase
Probability of prophylactic IVC filter:

157% increase
Variations in receiving an IVC Filter

LOWER:

• Smaller hospital (<100 vs >400)$^1$
• Rural location$^2$
• Uninsured (Prophylactic)$^3$

$^1$Vasc Endovasc Surg. 2012 Jan;46(1):21-25
$^2$JAMA Intern Med. 2013 Apr;173(7):506-512
Do IVC filters work?
Increased risk if DVT

**Figure 1.** Cumulative incidence of recurrent deep vein thrombosis. Kaplan-Meier analysis censoring for event, death, or date of last medical record documentation. IVC indicates inferior vena cava.

**Figure 2.** Cumulative incidence rate of subsequent/recurrent pulmonary embolism. Kaplan-Meier analysis censoring for event, death, or date of last medical record documentation. IVC indicates inferior vena cava.

Spenser et al., Arch Intern med 2010; 170(16)1456-1462
Risk of Death

Deep-vein thrombosis (%)

Survival probability

Year(s) after index deep-vein thrombosis

Hazard ratio, 0.97
P = 0.83

No filter
Filter

Circulation. 2005;112:416-422
All-cause mortality

Figure 4. Cumulative incidence rate of all-cause mortality. Kaplan-Meier analysis censoring for death or date of last medical record documentation. IVC indicates inferior vena cava.

Worcester Study
Complications of IVC Filters

- Placement- Very low (0.3%)\(^1\). Conventional and CO\(_2\) Fluoroscopy, Ultrasound
- DVT, Occlusion long term
- Caval Penetration
- Migration
- Fracture
- Inability to remove (<10%)\(^2\)
- J-wire entrapment from CVL placement

\(^1\)Radiology.2000;216(1):54
\(^2\)Am J Cardiol.204;94(8);1090
• If you place an IVC filter designed to be removed, then plan to remove it.

• Document why it was left in place
• Out of 240 pts only 30.4% had documented plans for removal
• Most had a justifiable reasons for retention
• 21% had no clear contraindication for removal
• Retrieval rate of 34%
• Average time to retrieval 72 days
• Mean follow up after filter was 10 months
• Overall filter retrieval failure rate 5.5% - increased with time - Most common causes were tilting (43%), adherence to wall (39%), large clot burden (18%)
• Most common reasons for not removing filter were loss to followup and continued risk

Indications after DVT and/or PTE

- Conventional anticoagulation in contraindicated
  - Active bleeding
  - Following recent surgery
  - Following a hemorrhagic stroke
- Conventional anticoagulation has proven ineffective
- Complication or higher risk of anticoagulation develops
- Pulmonary vascular beds are already significantly impacted and unlikely to tolerate another insult. (e.g. Massive PTE, Pulm HTN)
Indications for Prophylactic IVC Filter

- Data not as strong and it times conflicting
- After massive trauma or head trauma (incidence 0.36%)\(^1\)
- During endovenous intervention when embolization likely
- Perioperatively on high risk patients during period of anticoagulant discontinuation

**PLAN REMOVAL**

\(^1\)Ann Surg.2004;240(3):490
Who should not receive a Filter?

- Acceptable patients for anticoagulation.
- Stable patients after PTE
- IVCs too large for Filter
- Occluded IVCs
- Anatomic Variants
Vena cava variations

A: Partial malrotation and left IVC
B: Duplicated IVC with left IVC draining into the left renal vein
C: Azygos communication with the IVC; lack of continuity between the renal segment of the IVC and the hepatic segment
D: Circumaortic left renal vein (renal vein collar, double left renal vein)
E: Retroaortic left renal vein
F: Double IVC with hemiazygous continuation of the right IVC
G: Double IVC with retroaortic left renal vein and azygous communication with the right IVC; lack of continuity between the prerenal segment of the IVC and the hepatic segment
H: Circumcaval ureter
I: Absent infrarenal IVC; paravertebral collateral veins communicate via the azygous vein

IVC: Inferior vena cava

Renal vein anomalies

- **Type I** - Retroaortic left renal vein; normal level of drainage into the IVC.
- **Type II** - Retroaortic left renal vein, caudal level of drainage into the IVC (Lg/LS).
- **Type III** - Circumaortic left renal veins (venous collar); normal level of drainage into the IVC.
- **Type IV** - Retroaortic left renal vein, caudal level of drainage into the left iliac vein.
- Other (nonclassified) - Supernumerary renal veins, which can involve either kidney.

RLRV: retroaortic left renal vein; IVC: inferior vena cava; LRV: left renal vein.

THANK YOU!
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