Lead Implantation in Patients with ESRD on Hemodialysis

KHRS 9th Annual Scientific Session 2017
Woo-Hyun Lim, MD
CIEDs in General Population

- **Incidence**
  - United States
    - PPM: 60-70/100,000/year

- **Prevalence**
  - Western Australia
    - PPM: >2% for aged over 75


Bradshaw et al. *Open Heart* 2014;1:e000177.
Prevalence of CIEDs in ESRD pts

- **USRDS** (United States Renal Data System)
  - 546,769 ESRD patients (2005-2009)
  - CIEDs in 34,935 (6.4%)

- Delaware and Maryland, US
  - 1235 chronic HD patients (Jan 2011-Mar 2011)
  - 129 with CIEDs (10.4%)
    - 54 Pacemakers (4.2%)
    - 75 ICDs (5.8%)

---


Transvenous CIED lead Implantation in Patients with ESRD on HD

- Things to consider before implantation
  1. Central venous stenosis
     - Subclavian vein, brachiocephalic vein, or SVC
     - Symptomatic venous hypertension
  2. Primary failure of vascular access for hemodialysis
  3. Lead infection
  4. Potential for decreased ICD/CRT efficacy in ESRD patients
1. Central venous stenosis
Central Venous Stenosis

- **Mechanism**
  - Vessel injury → intimal hyperplasia or fibrosis
  - Fibrous pedicle → tether the leads to the vessel walls
  - Thrombus → organized thrombus

- **Worst combination**
  - Tunneled venous catheter
  - Ipsilateral CIED leads

Central Venous Stenosis in non-ESRD patients

- Only a small fraction of patients developed clinical signs of venous hypertension

229 patients included
First PPM implantation (Jan 1998 ~ Mar 1999)

202 underwent 6M F/U venography (27 died within 6 months)

129 (64%): Central vein stenosis
  - Mild: 27 (13%)
  - Moderate: 59 (30%)
  - Severe: 31 (15%)
  - Occlusion: 12 (6%)

6 (2.6%): U/E edema

Central Venous Stenosis in ESRD patients

- ESRD patients on HD
  - High-flow rate of U/E
    - Mean blood flow rate in mature AV fistula: 800-1200 mL/min
    - High rate of venous return
  - Endothelial dysfunction and vascular calcification

- CIED leads in ESRD patients on HD
  - Higher chance of central vein stenosis
  - Ipsilateral to AV access: higher chance of symptomatic venous hypertension (up to 70%)
    - Edema of U/E, face, neck, or breast
    - Associated dialysis access dysfunction
Intervention Rates in HD Pts with CIEDs

- Delaware and Maryland, US
  - 1235 chronic HD patients (Jan 2011-Mar 2011)
  - 129 with CIEDs (10.4%)
    - 54 Pacemakers (4.2%)
    - 75 ICDs (5.8%)
  - 137 separate instances of CIED and AV access in 129 patients over lifetimes on dialysis
  - Interventions
    - Angioplasty
    - Stenting
    - Thrombectomy
    - Surgical revision

<table>
<thead>
<tr>
<th>Instances of CIED and AV access</th>
<th>CIED and AV Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instances</td>
<td>All: 137</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 78</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 59</td>
</tr>
<tr>
<td>CIED left-sided</td>
<td>All: 101</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 45</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 56</td>
</tr>
<tr>
<td>CIED right-sided</td>
<td>All: 36</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 33</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 3</td>
</tr>
<tr>
<td>CIED prior to AV access</td>
<td>All: 82</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 34</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 48</td>
</tr>
<tr>
<td>AV access prior to CIED</td>
<td>All: 54</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 44</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 10</td>
</tr>
<tr>
<td>Unknown</td>
<td>All: 1</td>
</tr>
<tr>
<td></td>
<td>Contralateral: 1</td>
</tr>
<tr>
<td></td>
<td>Ipsilateral: 0</td>
</tr>
</tbody>
</table>

| Intervention rates              | All: 506 (1.48)    |
|                                 | Contralateral: 261 (1.44*) |
|                                 | Ipsilateral: 245 (1.53) |
| Number of access circuit        | All: 145 (0.43)    |
| interventions (access circuit   | Contralateral: 50 (0.28†) |
| rate per AY)                    | Ipsilateral: < 95 (0.59) |
| Number of central venous        | All: 0             |
| interventions (central vein      | Contralateral: 0   |
| rate per AY)                    | Ipsilateral: 0     |
| Interventions for superior vena | All: 0             |
| cava stenosis                   | Contralateral: 0   |
|                                 | Ipsilateral: 0     |

*p = 0.477 versus ipsilateral access circuit interventions.
†p < 0.001 versus ipsilateral central venous interventions.
Management of CIED-associated Central Vein Stenosis

- Treatment of symptomatic central vein stenosis
  - Percutaneous balloon angioplasty (PTA) without stent placement

- Patency rate of PTA for central venous stenosis
  - CIED leads (-): 12-50% at 12 months
  - CIED leads (+): 18% at 6 months, 9% at 12 months
    - Lead function following PTA: no adverse effect reported
    - Usually, repeated PTAs are required → lead function?

- PTA failure → Angioplasty plus stent insertion
  - Stenting over CIED leads: not recommended
  - CIED lead removal → PTA with stenting → CIED lead re-implantation

Case 1.

- F/82
- Sick sinus syndrome
- PM implantation on 2002.6.17.
  - Affinity DR (DDDR), SJM
- 2011.3.23. PM analysis
  - A lead impedance: very high in unipolar and bipolar mode
  - Changed mode: DDDR $\rightarrow$ VVIR
- 2013.11.16. PM analysis
  - Battery voltage: 2.49V
Venography: Lt subclavian vein occlusion
New A-lead insertion into occluded vein

0.014” guidewire Passage to IVC
Glide catheter advanced to IVC
Super Stiff Terumo
Long sheath insertion over the super stiff Terumo
New A-lead
Case 2.

- F/80
- HT, 3VD, s/p CABG (2006.10.27)
- AF c SVR
- Pacemaker implantation on 2006.11.1
  - Enpulse E2SR03 (VVIR), Medtronic
- 2013.10.31 pacemaker analysis
  - Estimated remaining battery longevity: 2.5 years
  - V-lead capture failure
  - High V-impedance (>9,999 ohms)
  - Lead warning
Venography: Lt brachiocephalic vein stenosis

Failure of sheath advancement over 0.35” wire
New V-lead insertion into occluded vein

- Glide catheter to IVC
- Super Stiff Terumo to IVC
- New V-lead insertion
2. Primary Failure of Vascular Access for HD
# Primary Failure Rate of Vascular Access

- Vascular access creation after CIED placement

<table>
<thead>
<tr>
<th></th>
<th>Vascular access ipsilateral to CIED (n=19)</th>
<th>Vascular access contralateral to CIED (n=17)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Failure (%)</td>
<td>15/19 (78.9)</td>
<td>6/17 (35.3)</td>
<td>0.02</td>
</tr>
<tr>
<td>Causes of primary failure (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-maturation (%)</td>
<td>8/15 (53.3)</td>
<td>2/6 (33.3)</td>
<td>0.64</td>
</tr>
<tr>
<td>Early Thrombosis (%)</td>
<td>4/15 (26.7)</td>
<td>2/6 (33.3)</td>
<td>1.00</td>
</tr>
<tr>
<td>Others</td>
<td>3/15 (20.0)</td>
<td>2/6 (33.3)</td>
<td>0.60</td>
</tr>
<tr>
<td>Arm swelling requiring ligation (%)</td>
<td>2/15 (13.3)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Collaterals (%)</td>
<td>1/15 (6.7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Arterial insufficiency (%)</td>
<td>0</td>
<td>1/6 (16.7)</td>
<td></td>
</tr>
<tr>
<td>Failed cannulation d/t depth (%)</td>
<td>0</td>
<td>1/6 (16.7)</td>
<td></td>
</tr>
</tbody>
</table>

3. CIED Infection
CIED Infection Rate

Causes of Increase in CIED Infection

1. Increase in ICD implantation

Causes of Increase in CIED Infection

2. Increase in comorbidities

Risk factors for CIED Infection, meta-analysis

- Average device infection rate: 1-1.3%
- Host-related risk factors
  - DM (OR 2.08 [1.62-2.67])
  - **ESRD (OR 8.73 [3.42-22.31])**
  - COPD (OR 2.95 [1.78-4.90])
  - Corticosteroid use (OR 3.44 [1.62-7.32])
  - **Prior device infection (OR 7.84 [1.94-31.60])**
  - Renal insufficiency (OR 3.02 [1.38-6.64])
  - Malignancy (OR 2.23 [1.26-3.95])
  - Heart failure (OR 1.65 [1.04-5.80])
  - Pre-procedural fever (OR 4.27 [1.13-16.12])
  - Anticoagulant drug use (OR 1.59 [1.01-2.48])
  - Skin disorder (OR 2.46 [1.04-5.80])
CIED leads and Permacath

- Dangerous combination
- Late CIED infection
  - Remote source of bacteremia in 38%

LATE

Management of CIED lead-associated endocarditis

- Removal of all CIED hardware and a prolonged course of intravenous antibiotics
- Lead removal can be accomplished in >95% of cases without open heart surgery
- In-hospital mortality of CIED lead extraction for endocarditis: 4.3%, but increased to 12.4% with Cr >2.0mg/dL
4. Potential for decreased ICD/CRT efficacy in ESRD patients
Case 3.

- M/72
- DM-ESRD on HD via Lt arm AVF (2007.12-)
- Ischemic CMP (EF=26%)
  - s/p PCI (x6, stent x8)
- AVB
  - s/p PM (DDD, 2010.12)
- ASO
  - s/p PTA (x2), toe amputation
- Sustained VT during HD
ICD vs. CRT-D

ICD
- 평소 호흡곤란 별로 호소하지 않음: Wheal chair ambulation
- Survival gain 이 별로 없을 것이다.
- Technical difficulty:
  - Rt subclavian vein stenosis
  - Rt side approach for coronary sinus cannulation

CRT-D
- 투석 효율 증대: 투석시 혈압 저하 및 투석 횟수 감소 기대
- Survival gain 이 조금이나마 있을 것이다.
ESRD or CKD 4-5 with indication for CIED

Multidisciplinary team approach

AV Access (+)
- CIED leads contralateral to existing AV access
- Epicardial leads Leadless PM

AV Access (-)
- Peritoneal dialysis
- Venography and US vein mapping
- CIED leads contralateral to expected AV access
- Epicardial leads Leadless PM

Venous catheter
- Avoid CIED implantation if possible
- Construct AV access ASAP
  - Remove venous catheter
  - CIED implantation
- Peritoneal dialysis
- Epicardial leads Leadless PM

Recommendation
감사합니다.