Lead extraction: planning, approaches and complication

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Prevalence

- Lead extraction may be necessary for a variety of reasons.
  - >45 years since endocardial leads introduced
  - Increased number of occasional implanters in non-operating rooms
  - On average, 10% of all leads implanted may require removal

**USA**

- Implantation; ≈ 400,000 devices/year
- >3 million patients with implanted cardiac devices currently

- On average, 10% of all leads implanted may require removal
Global Lead extraction Results

A pronounced decline in the incidence of procedure related morbidity and mortality - high volume centres reported high success rate with low complication rates

Maytin M, Epstein LM. Heart 2011;97:425e434
Pacemaker, ICD, and CRT in Korea

- The progressive increase of CIED recipients leads to an amplified need for lead extraction.
M/39, ICD 2.5 yr ago
A case of ICD lead extraction
The Chronic Lead

- Why does an implanted cardiac lead pose such a problem at time of removal?
Lead Removal

• Within the general category of “lead removal”, the Heart Rhythm Society marks the distinction between;

• Lead explant
  – < 1 yr, simple procedure

• Lead extraction
  – > 1 yr, “specialized” equipment
Indication
Indication
- Transvenous Lead Extraction -

1. Infection
2. Chronic pain
3. Thrombosis or venous stenosis
4. Functional leads
5. Non functional leads

Prevalence of Infection

• ≈ 60% of the lead extractions required are due to infection.

• Infection and erosion are higher after elective unit replacement (6.5%) than after a first implant (1.4%).

• 25% of infections occurred with the first month, 33% occurred late (29-364 days), and 42% were delayed, presenting beyond one year.
Management

• Complete device and lead removal is important.
• Persistence of infection has been described in up to 77% of patients in whom only the generator was removed.
• Prolonged antibiotic treatment coupled with partial explantation results in further morbidity and cost.
63 Male, Fever & confusion for 3 days

Antibiotics approach to management of adults with CIED infection

Circulation. 2010;121:458-477
19 Female, chills for 3 days

Lead extraction

Approach to implantation of a new device in patients after removal of an infected CIED

Implantation of a new CIED

Blood cultures (+) TEE (+)
Repeat blood cultures after CIED removal
Valve vegetation
Implant new CIED after 14 days from first negative blood culture

Lead vegetations only
Implant new CIED if repeat blood cultures remain negative for 72 hours

Blood culture (+) TEE (-)
Repeat blood cultures after CIED removal
Implant if repeat blood cultures are negative for at least 72 hours

Generator pocket Infection/Generator or lead erosion
Negative blood cultures for 72 hours
Implant new CIED following adequate debridement of the generator pocket

Circulation. 2010;121:458-477
Remnant lead

Chronic pain

- There is **severe chronic pain**, at the device or lead insertion site
- **Pain** that is not manageable by medical or surgical techniques and there is no other alternative

Thrombosis or Venous Stenosis

- Clinically significant **thrombo-embolic events** associated with thrombus on a lead or a lead fragment
- Bilateral subclavian vein or superior vena cava **occlusion** precluding implantation of a needed transvenous lead

Functional and Non Functional Leads

- **Life threatening arrhythmias** secondary to retained leads or lead fragments
- Leads that, due to their design or their failure, may pose an **immediate threat to the patients** if left in place
- Leads that **interfere with the operation of implanted cardiac device** or the treatment of malignancy
Percutaneous Extraction Techniques
Percutaneous Extraction Techniques

• Superior Approach: Extraction via the implant site

• Femoral Approach: Extraction via the femoral vein (when the subclavarian approach is not possible)
Alternative Approaches

• Pulling....
• Weighed Traction
• Thoracotomy

Pulleys & Weights
Lead Extraction

LEAD EXTRACTION™
LIBERATOR® LOCKING Stylet

To engage stylet:
• Remove Latch-pin (inset).
• Firmly advance the activator cannula forward.
LEAD EXTRACTION™
Manual Mechanical Telescoping dilator Sheath Sets

Polypropylene

Stainless steel

Counter Traction

A

B
Lead Extraction – Laser -
EVOLUTION®
Mechanical Dilator Sheath Set

Sheath rotates when the trigger handle is squeezed for maximum operator control.

- The patented threaded barrel tip provides succinct passage past fibrous binding sites without the “forward depth of cut” of other powered sheaths.
- Available in four sizes that are compatible with both pacing and defibrillator leads: 7, 9, 11 & 13 Fr. (I.D.)
Femoral Extraction
Complications
Major Complications

• Death
• Surgical tear (cardiac or vascular)
• Pulmonary embolism requiring survival intervention
• Stroke
• New onset infection to the pacing system
• Anesthesia complications

The Danger Zone
- Tear of puncture of SVC

Perforation of the innominate vein

Avulsion of right ventricle
Predictors of Major Complications

• Implant duration of oldest lead
• Female gender
• ICD lead removal
• Use of laser
Minor Complications

- Pericardial effusion
- Hemothorax, arm-swelling or thrombosis of implant veins, pneumothorax, hematoma, vascular repair
- Hemodynamically significant air embolism
- Migrated lead fragment
- Blood transfusion
- Pulmonary embolism

Lead Extraction in Severance Hospital

### Device characteristics

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 110)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead implant duration (years)</td>
<td>4.8±5.2</td>
</tr>
<tr>
<td>Device type</td>
<td></td>
</tr>
<tr>
<td>Pacemaker</td>
<td>77 (70)</td>
</tr>
<tr>
<td>ICD</td>
<td>27 (24.5)</td>
</tr>
<tr>
<td>CRT</td>
<td>6 (5.5)</td>
</tr>
<tr>
<td>Implantation hospital</td>
<td></td>
</tr>
<tr>
<td>other hospital</td>
<td>104 (94.5)</td>
</tr>
<tr>
<td>Severance hospital</td>
<td>6 (5.5)</td>
</tr>
</tbody>
</table>

~2014

### Device & lead type

- PM DDD: 41%
- PM VVI, VDD: 29%
- ICD dual coil: 6%
- ICD single coil: 18%
- CRT D: 5%
- CRT P: 1%
- V SCREW / TINED: 62 (44)
- A SCREW/TINED: 68 (44)
- LV LEAD: 3
Causes of Lead Extraction

- Lead problem: 13.6%
- Others: 9.1%
- CIED infection: 78.2%

<table>
<thead>
<tr>
<th>Lead extraction causes</th>
<th>Overall (n = 110)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>86 (78.2)</td>
</tr>
<tr>
<td>CIED infection, systemic</td>
<td>12 (10.9)</td>
</tr>
<tr>
<td>CIED infection, localized</td>
<td>74 (67.3)</td>
</tr>
<tr>
<td>Non-infection</td>
<td>24 (21.8)</td>
</tr>
<tr>
<td>lead problem</td>
<td>15 (13.6)</td>
</tr>
<tr>
<td>others*</td>
<td>9 (8.2)</td>
</tr>
</tbody>
</table>

- Methods of lead extraction:
  - Simple traction: 27 (24.5)
  - DT/CT with a locking stylet: 70 (63.6)
  - Others: 5 (4.5)

- Number of lead removed: 1.33 ± 0.51
- Procedure time, min: 95.4 ± 53.7
- Major complication: 3 (2.7)

- DT/CT, direct traction/counter traction
- * major complication: death, stroke, pulmonary embolism requiring intervention, cardiac tamponades requiring pericardiocentesis

백용수. 심장학회 2015
Clinical Outcome

110 Lead extracted patients by transverse lead extraction

- Complete Success (n=101) (91.8%)
  - Cardiac tamponade (n=2)

- Partial Success (n=4) (3.6%)
  - Cardiac tamponade (n=1)

- Failure (n=5) (4.5%)
  - Surgical removal (n=6)
Lead Management Environment: Personnel

- Primary operator
- Cardiothoracic surgeon
- Anesthesia support
- Echocardiographer
- X-ray technician
Physician qualifications

- For physicians performing their first case, 12% of leads were not removed.
- For physicians that have performed >10 cases, only 2% of leads were not removed.
- Analysis of lead extraction outcomes suggests that the frequency of procedural (radiographic) failure drops dramatically after the first 10-20 procedures have been performed.
- Current procedure related mortality is less than 0.5%, less than 0.2% at experience centers.
시술전 준비

• 환자와 보호자에게 시술에 대한 충분한 설명
• Baseline blood test (CBC, SMA, INR,,)
• Blood type, crossmatch
• 혈액 준비 (> 4units)
• Large bore venous access (8Fr sheath)
• Temporary pacing, defibrillation 준비
• ECG, BP monitoring
• pericardiocentesis 준비
• 흉부외과 준비
Take Home Message

• The number of lead extraction procedures is rising sharply in parallel with ever increasing indications for pacemaker implantation.
• Current procedure related mortality is less than 0.5%, less than 0.2% at experience centers.
• For physicians that have performed >10 cases, only 2% of leads were not removed.
• Long implantation time, lack of operator experience, ICD lead type and female gender are risk factors for complications.
Thank you for your attention.