Hybrid catheter intervention for acute massive pulmonary thromboembolism

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Iri Clinic, Saitama***

Short story: Nippon Medical School, Hideyo Noguchi, and Danmark
Nippon Medical School, Hideyo Noguchi, and Danmark

Nippon Medical School was founded in 1876.
Banknotes of Japanese
Yen

Hideyo Noguchi MD,PhD (1876-1928)
Japanese famous bacteriologist.
Banknotes of Japanese 1000 Yen

Hideyo Noguchi MD, Ph D
Studied medicine at
SAISEIGAKUSYA
(Nippon Medical School)
Banknotes of Japanese 1 0 0 0 Yen

Hideyo Noguchi MD, PhD
Worked as a guest researcher at Statens Serum Institut, Copenhagen, 1903.
T Madsen, Director of Statens Serum Institut and H Noguchi
Banknotes of Japanese 1000 Yen

Hideyo Noguchi MD, PhD (1876-1928)
Returned to Rockefeller Institute, New York.
Succeeded in pure culture of syphilis spirochaete.
Candidate for Nobel Prize; 4 times.
Died of yellow fever at Ghana, Africa.
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Background:
Traditional treatment of acute pulmonary thromboembolism

1. Anticoagulation
2. Systemic thrombolysis → Percutaneous catheter intervention
3. Surgical thrombectomy → Percutaneous catheter intervention

(JVIR 2001;12:147)
Indication:
Acute massive PTE→Severe right heart failure

• Haemodynamics
  1. Mean PAP > 25mmHg (Pulmonary HT)
  2. Shock index (HR/SBP) > 1

• Angiographic findings
  1. Angiography severity index > 9 (max 18)
  2. Miller score > 20 (max 34)

Contents:
Percutaneous catheter interventions for the treatment of acute massive pulmonary thromboembolism

1. Catheter directed thrombolysis (CDT)
2. Catheter tip embolectomy
   A. Aspiration thrombectomy
   B. Fragmentation
   C. Rheolytic thrombectomy

(JVIR 2001;12:147)
Catheter directed thrombolysis (CDT)  

UK  250,000unit/ h ( + heparin 2000 IU) x 2 h  
   + 100,000unit/ h x 12 - 24 h  

  t -PA  10mg Bolus  +  20mg/ h x 2 h  
   or  100mg/7 h  

(Uflacker, JVIR 2001;12:14)

Super-selective CDT  

Pulse-spray thrombolysis
Aspiration thrombectomy

Greenfield Embolectomy Device

Lang Percutaneous Thrombectomy Device
Lang EV et al. JVIR 1997;8:427.

1. Catheter directed thrombolysis
2. Catheter tip embolectomy
A Aspiration thrombectomy
B Fragmentation
C Rheolytic thrombectomy

(Uflacker JVIR 2001;12)
Aspiration thrombectomy with PTCA guiding catheter (Meyerovitz technique)

佐藤文則ら 心血管 1989;4:204
中崎育明ら 呼と循 1989;37:1363
井上一郎ら 脈管学 1994;34:875
Hiramatsu S et al J Cardiol 1999;34:71
Aspiration thrombectomy devices

Thrombuster II・III、TVAC、New Export、Rebirth、Eliminate、etc.
1. Catheter directed thrombolysis
2. Catheter tip embolectomy
   A. Aspiration thrombectomy
   B. Fragmentation
   C. Rheolytic thrombectomy

Guidewire
   唐川正洋ら 心血管 1993;8:105
   井上一郎ら 心臓 1994;26:1010

Balloon Angioplasty
   Handa K et al. Angiology 1988;8:775
   Fava M et al. JVIR 1997;8:261

Kensey Dynamic Device
   Stein PD et al. Chest 1990;98:994

Impeller Basket Device
   Schmitz-Rode T et al. Radiology 1991;180:135
   (Uflacker JVIR 2001;12)
1. Catheter directed thrombolysis
2. Catheter tip embolectomy
   A Aspiration thrombectomy
   B Fragmentation
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**Fragmentation 2**

**Thrombolyzer**
- Schmitz-Rode T et al. CVIR 1996;19:165

**Rotatable Pigtail Catheter**
- Schmitz-Rode T et al. Chest 1998;114:1427
(Uflacker JVIR 2001;12)

**Arrow-Trerotola Device**
- Brown DB et al. JVIR 1999;10:733

**Amplatz Thrombectomy Device**
- Uflacker R et al. JVIR 1996;7:519

**Rotarex Catheter**
- Schmitt H-E et al. CVIR 1999;22:504
Aspirex (Straub Medical)
Radiology 2005;236:852

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length</td>
<td>120 cm</td>
</tr>
<tr>
<td>Maximum external diameter</td>
<td>11.2 F (3.75 mm)</td>
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<tr>
<td>Sheath compatibility</td>
<td>11 F</td>
</tr>
<tr>
<td>Guidewire compatibility</td>
<td>0.035 inch; length, 260 cm</td>
</tr>
<tr>
<td>Catheter body</td>
<td>Polyurethane, stainless steel, perfluoroethylene-propylene</td>
</tr>
<tr>
<td>Flexible catheter tip length</td>
<td>41 cm</td>
</tr>
<tr>
<td>Motor-catheter connection</td>
<td>Magnetic clutch with torque lock</td>
</tr>
<tr>
<td>Rotary speed</td>
<td>32 500 rpm</td>
</tr>
<tr>
<td>Speed torque</td>
<td>25 mNm</td>
</tr>
<tr>
<td>Maximum aspiration pressure*</td>
<td>11.3 kPA</td>
</tr>
<tr>
<td>Minimum catheter bend radius</td>
<td>21 mm</td>
</tr>
</tbody>
</table>
Rheolytic thrombectomy

Hydrolyser
  Fava M et al. JVIR 2000;11:1159
畑中義美ら. IVR学会誌 2002;17:347

Oasis

AngioJet
  Zeni PT et al. JVIR 2003;14:1511

Modified Hydrolyser
  Reekers JA et al. CVIR 2003;26:246
1. Catheter directed thrombolysis (CDT)
2. Catheter tip embolectomy
   A. Aspiration thrombectomy
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Hybrid catheter intervention
Hybrid catheter intervention

Procedures:
1. PAP (Pulmonary arterial pressure) measurement, PAG (Pulmonary angiography)
2. Long sheath insertion to PA trunk
3. Local fibrinolytic therapy: rt-PA*
4. Fragmentation using Rotatable Pigtail Catheter
5. Aspiration thrombectomy
6. PAP measurement, PAG
7. Post procedure treatments

*rt-PA: recombinant human-tissue plasminogen activator

(H Tajima et al. AJR 2004;183:589)
Hybrid catheter intervention

Post procedure treatments:

1. Temporary IVC filter insertion as protection against recurrent PE

2. Additional systemic urokinase infusion
   The dosing regimen originally was 24-48x10^4 IU per day for 3 days

3. Catheter intervention for the residual deep vein thrombosis
Case presentation

Pre intervention

101 min after intervention
Hybrid catheter intervention

Complications:
(Major) One case of cardiac arrest during pigtail catheter rotation, but recovered. One case of pulmonary artery perforation during aspiration, but rescued by micro-coil embolization.
(Minor) One case of catheter shaft fragmentation during catheter rotation, easily pulled out.
Coil embolization for vascular injury

extravasation

coil embolization

(H Tajima, et al. CVIR 2006;29:15)
Hybrid catheter intervention

Discussion-1-:

The goal of the intervention?

→ The angiographic result of the catheter intervention is less important. The procedure should be terminated once hemodynamic improvement is achieved, regardless of the extent of residual emboli in the pulmonary angiogram. (Chest 2008;134:2)
Hybrid catheter intervention

Discussion-2-:

How to prevent distal embolization after the fragmentation of massive thrombi?
→ Aspiration thrombectomy should be added.

( Brit J Radiol 2008; 81: 848 )
Distal embolization is rescued by the aspiration thrombectomy.
Discussion -3-:
For the safety of the procedure:
Continuous monitoring of the pulmonary arterial pressure during the procedures.
Mean pulmonary arterial pressure (PAP) change due to mechanical thrombectomy

Elevation of mean PAP

No Change of mean PAP

Decrease of mean PAP

Distal embolization

No Distal Embolization

Discussion- 4 -: New references for catheter intervention

Instituto Nacional de Cardiologia, Mexico City

Severe PTE 18 case

**Fragmentation** with 6Fr pigtail catheter
  + **Aspiration** thrombectomy(8Fr Aspirex)

Major side effects 11%

(Shock→death: 1, Cerebral hemorrhage: 1)

No cardiovascular death and recurrence after 12 months follow up.
Discussion-5-: New references for catheter intervention.


Fig1. Combination of thrombus fragmentation with aspiration thrombectomy.

They evaluated the future of combination of thrombus fragmentation with aspiration thrombectomy, and stressed that “experienced team” is needed for excellent results.
Discussion-5-:

* To keep respiratory and hemodynamic status → Intubation, PCPS (Percutaneous Cardiac Pulmonary Support), etc

* Prevention of 2nd attack of PE → IVC filter, etc

* Thrombi of the right atrium → Contra-indication of catheter intervention
Recommendation class and evidence level of catheter intervention for acute PTE

• European society of cardiology 2008
Guidelines on the diagnosis and management of acute massive pulmonary embolism. The task force for the diagnosis and management of acute pulmonary thromboembolism of the European Society of Cardiology. European Heart Journal (2008) 29;2276-2315

• Classes of recommendation:

I Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, and effective.

II Conflicting evidence and/or a divergence of option about the usefulness/efficacy of the given treatment or procedure

III Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful
Guidelines on the diagnosis and management of acute massive pulmonary embolism. The task force for the diagnosis and management of acute pulmonary thromboembolism of the European Society of Cardiology. European Heart Journal (2008) 29; 2276-2315

- Levels of evidence:
  
  A Data derived from multiple randomized clinical trials or meta-analyses
  
  B Data derived from a single randomized clinical trial or large non-randomized studies
  
  C Consensus of opinion of the experts and/or small studies, retrospective studies, registries
Recommendation acute treatment of high risk patients:

Catheter embolectomy or fragmentation of proximal pulmonary arterial clots may be considered as an alternative to surgical treatment in high-risk patients when thrombolysis is absolutely contraindicated or has failed.

- Class of recommendation: II b
- Level of evidence: C
Recommendation acute treatment of high risk patients:
Surgical pulmonary embolectomy is a recommended therapeutic alternative in patients with high-risk PE in whom thrombolysis is absolutely contraindicated or has failed.

- Class of recommendation: I
- Level of evidence: C
For most patients with PE, we recommended against use of interventional catheterization techniques (Grade 1C). In selected highly compromised patients who are unable to receive thrombolytic therapy because of bleeding risk, or whose critical status does not allow sufficient time for systemic thrombolytic therapy to be effective, we suggest use of interventional catheterization techniques if appropriate expertise is available (Grade 2C).
Antithrombotic therapy for venous thromboembolic disease.

4.5 Pulmonary embolectomy for the initial treatment of PE

In selected highly compromised patients who are unable to receive thrombolytic therapy because of bleeding risk, or whose critical status does not allow sufficient time for systemic thrombolytic therapy to be effective, we suggest that pulmonary embolectomy may be used if appropriate expertise is available (Grade 2C).
Levels of evidence

A Data derived from multiple randomized clinical trials or meta-analyses
B Data derived from a single randomized clinical trial or large non-randomized studies
C Consensus of opinion of the experts and/or small studies, retrospective studies, registries

Jan 1990-Sept 2008
594 patients
35 studies (6 prospective, 29 retrospective)

Meta-analysis

Clinical success: stabilization of hemodynamics, resolution of hypoxia, and survival to hospital discharge

Pooled clinical success rate 86.5% (95% Confidence Interval: 82.1%, 90.2%)

Pooled risks of minor procedural complications 7.9% (95%CI: 5.0%, 11.3%)

Pooled risks of major procedural complications 2.4% (95%CI: 1.9%, 4.3%)

Conclusions: Modern CDT is a relatively safe and effective treatment for acute massive PE. At experienced centers, CDT should be considered as a first-line treatment for patients with massive
Catheter interventions for acute massive PTE

- No controlled clinical trials have been performed that have compared surgical embolectomy with catheter interventions. (Chest 2007;132:657)

- The results of small cohort studies have suggested that the clinical outcome after percutaneous catheter intervention is comparable to that after surgical embolectomy. (Am J Cardiol 2007;99:415)
Summary (2) meta-analysis

Modern CDT is a relatively safe and effective treatment for acute massive PE. At experienced centers, CDT should be considered as a first-line treatment for patients with massive PE. (JVIR2009;20:1431)

急性塊状肺血栓塞栓症に対するIVR治療は、比較的安全で効果的な治療法である。経験の十分なセンターにおいては、まず試みられるべき治療法である。
Banknotes of 500 DDK

Niels Bohr (1885-1962)
Niels Bohr, 1937 KAMAKURA
Niels Bohr, 1937 KAMAKURA
SJRS 2008 KAMAKURA