Percutaneous Thrombus Aspiration using AngioVac

The Perfusionists’ view

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Disclosures

- The speaker declares no conflict of interest
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Introduction

- The AngioVac system (AngioDynamics, Latham, NY, USA) provides a method for the minimally invasive, percutaneous aspiration of thrombus-formations originating from the central venous system, solid matter such as lead-vegetations and right-atrial thrombi.

- Avoidance of Sternotomy and Cardiopulmonary Bypass.

- The initial experience in the series of 52 adult patients led to the improvement of the extracorporeal circuit to achieve greater feasibility and safety.
Introduction

Surgical extraction

Percutaneous aspiration… „ηλεκτρική σκούπα θρόμβου “
Indications

- Systemic Cardiovascular Implantable Electronic Device (CIED) infection with large lead vegetations
- Central venous catheter thrombi or vegetations
- Right atrial thrombus
- Thrombus in SVC or IVC

Limited Indications

- Pulmonary embolism (current device design)
- Tricuspid valve endocarditis (debulking, No significant TR!)

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Vascular Access Configurations

**IJ – FEM – Configuration:**
RIGHT IJ vein: AngioVac Cannula (Aspiration)
Femoral vein: Reinfusion Cannula

**FEM – FEM – Configuration:**
RIGHT femoral vein: AngioVac Cannula (Aspiration)
LEFT femoral vein: Reinfusion Cannula
Vascular access

Lead vegetations – FEM-FEM

Right atrial & SVC thrombus – FEM-FEM

IVC thrombus & pulmonary embolism & TV vegetations – IJ-FEM

RULE: AngioVac against the bloodstream!

(Exception: pulmonary embolism)
Clinical Experience – Patient characteristics

- Initial series 52 patients (June 2015 - May 2018)
- Mean patient age 62.9 y (23 to 86 y)
- 22 female (42%) / 30 male (58%)

Indication

- Lead-vegetations (n=36) - 69%
- Right atrial thrombi (n=9) - 17%
- Central-venous thrombi (n=5) - 10%
- Pulmonary artery-embolism (n=2) - 4%
Clinical Experience – procedural results

1 major complication: Tricuspid regurgitation II°-III°
1 fatality (septic shock, not device related), Procedure aborted, case excluded

(10/2018: n=70)
Procedural Success

- Jabaar et al. (2018): Meta Analysis n=18 - 83% (partial and complete)
- Moriarty et al. (2016): 67% (right atrial; n=6)
  100% (caval; n=10)
- Michelson et al. (2017): 94% (caval thrombi & valve vegetations)
- D´Ayala et al. (2017): 100% (iliocaval; n=4)
  60% (right heart; n=5)
  33% (pulmonary embolus; n=3)
Clinical Experience – Lead vegetations

Managing large lead vegetations in transvenous lead extractions using a percutaneous aspiration technique

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Table 1. Basic characteristics of patients.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>35</td>
</tr>
<tr>
<td>Mean age</td>
<td>67.7 years (31–86)</td>
</tr>
<tr>
<td>Male/female</td>
<td>26/9</td>
</tr>
<tr>
<td>Infection:</td>
<td></td>
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<tr>
<td>Systemic CIED infection</td>
<td>35 (100%)</td>
</tr>
<tr>
<td>Additional local pocket infection</td>
<td>3 (8.6%)</td>
</tr>
<tr>
<td>Clinical symptoms of infection:</td>
<td></td>
</tr>
<tr>
<td>Fever (&gt;38.5°C)</td>
<td>35 (100%)</td>
</tr>
<tr>
<td>Local symptoms related to device pocket</td>
<td>3 (9%)</td>
</tr>
<tr>
<td>Septic shock</td>
<td>6 (17%)</td>
</tr>
<tr>
<td>Mean time from diagnosis to procedure</td>
<td>10.9 ± 9.3 days</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>12 (34.3%)</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>20 (57.1%)</td>
</tr>
<tr>
<td>Mean left ventricular function (EF)</td>
<td>38.7 ± 14.3 %</td>
</tr>
<tr>
<td>Number of targeted leads</td>
<td>83</td>
</tr>
<tr>
<td>Mean lead implant duration</td>
<td>56.1 months (1–200)</td>
</tr>
<tr>
<td>Lead characteristics:</td>
<td></td>
</tr>
<tr>
<td>Pacemaker leads</td>
<td>53</td>
</tr>
<tr>
<td>ICD leads (single versus dual coil)</td>
<td>30 (15/15)</td>
</tr>
<tr>
<td>Preoperative mean vegetation size (assessed by TEE)</td>
<td>22.6 mm (12–40)</td>
</tr>
<tr>
<td>Postoperative mean vegetation size (assessed by direct measurement)</td>
<td>33.6 mm (10–60)</td>
</tr>
</tbody>
</table>

Table 2. Procedural data and outcomes.

| Outcome percutaneous aspiration procedure          | 31 (88.6%)     |
| Complete procedural success                        |                |
| Partial success                                    | 3 (8.6%)       |
| Major complications (aspiration procedure related) | 0 (0%)         |
| Lead extraction devices                            |                |
| Locking stylet                                     | 53 (63.8%)     |
| Polypropylene extraction sheath                    | 1 (1.2%)       |
| Powered rotational extraction sheath               | 46 (55.4%)     |
| Outcome TLE procedure                              |                |
| Complete procedural success (per patients)         | 34 (97.1%)     |
| Clinical success (per patients)                    | 34 (97.1%)     |
| Major complications TLE related (per patients)     | 1 (TLE related high grade TR) |
| Mortality                                          |                |
| Operative mortality (not procedure related)        | 1 (2.9%)       |
| (due to refractory septic shock)                   |                |
| Survival                                           |                |
| 30-day survival                                    | 34 (97.1%)     |

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Inflow Cannula

- AngioVac Cannula: Venous drainage cannula indicated for removal of soft, fresh thrombi or emboli during extracorporeal bypass for up to 6 hours.
- 22 Fr. coil-reinforced, straight or 20° angled tip
- Balloon actuated, expandable funnel shaped inflow

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AngioVac - Standard Setup at the DHZB
AngioVac - Standard Setup at the DHZB

- Trap with Filter
- Occluder
- Line towards Patient
- Line from Patient
- Filling-Lines
- (Emergency) Hand crank
- Bubble-Detector
- Pump

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Safety Features inspired by MiECC-Systems

Bubble-Detector
Venous Negative Pressure Monitoring
Occluder

Terumo ROC-Safe
Circuit Priming

- (Bubble) Trap Terumo BT15 (170 µm) 150 ml
- Revolution Pump 57 ml
- 3/8“ Lines (~ 300 cm) 213 ml
  420 ml

- Balanced electrolyte solution
- No Heparin added
- Non-coated surfaces due to limited circulation time
AngioVac – Clinical Setup
Procedure - Requirements

- **Hybrid OR** = ideal environment
- **ECC-Standby** (fully operational)

- General anaesthesia
- Invasive Blood-pressure monitoring
- Central Venous lines from left side
- Keep Right Side free for 6 Fr. Sheath (IJV-access / snare application)
- Transesophageal echocardiography (and TEE-experienced physician!)

- Target ACT: > **250 sec.** (Heparin i.v.)
Procedure

Femoral Access

- RFV = 26 Fr. Gore Dry Seal Sheath + AngioVac cannula
- LFV = 18 Fr. (or 16 Fr.) Edwards FemFlex II cannula
  + distal 9F sheath („snare access“)
- LFA = 5 Fr. sheath („Quick Access Rescue Arterial Cannulation“)

Procedure Guidance by TEE & Fluoroscopy:
- Implantation: Mainly Fluoroscopy-Guidance
- Aspiration: Mainly TEE-Guidance
AngioVac – Procedure (caval)

Courtsey of C.T. Starck, DHZB 2018
Procedure

Moment of **desired suction** of solid material shown by:

- **Flow drop** at constant RPM
- **Tube shaking** on aspiration line
- Visibility of material in the trap

Close communication between Perfusionist, Surgeon and Anaesthesiologist!

**Obstruction of cannula**

→ increase RPM *or* remove cannula

Cave: **Suction of cardiac structures** (e.g. IAS)

→ decrease RPM *and* reposition cannula

- If **temporary stop** of aspiration: “shunt-run“ of ECC-circuit
- Termination of procedure -> **antegrade Retransfussion** via Returning cannula
AngioVac – Procedure
Suction and Hemolysis

- Concerns about negative pressure causing Hemolysis
- Experimental indication for a threshold of -120 mmHg until damage
- Negative pressures exceeding -120 mmHg: linear increase of free Hb
Negative Pressure Monitoring during procedure

![Graph showing negative pressure monitoring during a procedure. The graph plots pressure (mmHg) against flow (l/min) for different veins: shunt, femoral vein, and jugular vein. The x-axis represents flow (l/min) from 0.5 to 5, and the y-axis represents pressure (mmHg) from -200 to 0.]
AngioVac – Captured Material

Pictures courtesy of C. Starck, DHZB 2018
AngioVac – Captured Material

▪ Mean size of captured thrombi was 21.5 x 13.1 mm
▪ Thrombus size varied from 7 – 40 mm in length and 3 – 28 mm in width.
▪ Appearance as a whole or fragmented into pieces.
Conclusion

- AngioVac showed safety and efficiency.
- **Facilitates** percutaneous, transvenous extraction in large lead vegetations.
- The installation of a **shunt-line** enables breaks during the procedure without stasis in the circuit.
- Negative pressures seem to reach critical levels only during actual point of aspiration.
- Safety features should include **de-airing possibility** an **backup with Heart-Lung-Machine** for rapid transformation.
Thank you for your attention.

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