Science behind Rotational Atherothrombectomy
– SAVioR IVUS study

Prof. Dr. med. Christos Rammos, MHBA
Department of Cardiology and Vascular Medicine
West-German Heart and Vascular Center Essen
University of Duisburg-Essen
Disclaimer

This presentation is on behalf of Becton, Dickinson and Company. Any discussion regarding Becton, Dickinson and Company products during the presentation today is limited to information that is consistent to approved indications for use for those products. Please consult Becton, Dickinson and Company product labels and inserts for any indications, contraindications, hazards, warnings, cautions and instructions for use.

The opinions and clinical experiences presented herein are for informational purposes only. The results from this case report may not be predictive for all patients. Individual results may vary depending on a variety of patient specific attributes.

The clinicians have been compensated by Becton, Dickinson and Company to participate in this presentation.
Disclosures

I have the following potential conflicts of interest to report (Honoraria/Consultant):

- BD Bard
- BMS Pfizer
- BIOTRONIK
- Veryan Medical

- M.A. Medalliance
- PMI
- Boston Scientific
- Shockwave
Contents

• Background
• SAVioR Trial - Endothelial Function
• SAVioR-IVUS Trial – Plaque Burden & Virtual Histology
• Conclusion
Objectives for treatment strategies for PAD

Restore tissue perfusion!
Achieve patency!

Impact on prognosis
Cardiovascular risk for PAD

CVD with PAD
(N = 1.036)
14.9 %
P = 0.0028

CVD without PAD
(N = 11.996)
7.6 %

Risk for cardiovascular endpoint

Days since randomization
Progression of atherosclerotic vascular disease

Endothelial Dysfunction

Pepine, Am J Cardiol 1998;82(3A):21H-24H
Anti-inflammatory activity
Inhibition of leukocytes adhesion and invasion

Anticoagulatory and profibrinolytic activity

Endothelium-dependent Vasodilation

Antihypertrophic activity
Inhibition of proliferation and migration of SMC

Antithrombotic activity
Inhibition of platelet aggregation and adhesion

Normal Endothelium
Endothelial function is prognostic relevant in atherosclerotic disease

Endothelial function is prognostic relevant in atherosclerotic disease.
Endothelium dependent vasodilation
Determination by flow mediated dilation (FMD)

Correlation of brachial and femoral artery endothelial function

Controls

PAD

r = 0.7
p = 0.01

r = 0.4
p = 0.01
Contemporary treatment rationale – lesion preparation

- Impact on vessel function?
- Effect on prognosis?

Mechanical Rotational Atherothrombectomy (Rotarex™ S) and DCB

Adapted from Fanelli, Cardiovasc Intervent Radiol 2014;37(4):898-907
Contents

• Background

• SAVioR Trial - Endothelial Function

• SAVioR-IVUS Trial – Plaque Burden & Virtual Histology

• Conclusion
Safety and efficacy of Atherectomy on VasculaR functions -
The SAVioR trial
Two-armed nonrandomized open label pilot trial

Rotarex™ S atherectomy and DCB (n=15), Bail-out stenting
Standard predilation (POBA) and DCB (n=15), Bail-out stenting

Baseline preinterventional
Acute Effect 2 d FU
Chronic Effect 6 Months FU

- Safety and technical success
- Primary Patency
- Vascular function

Clinicaltrials.gov NCT04092972
### The SAVioR trial – Results

#### Baseline patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Mechanical Atherothrombectomy + DCB (n=15)</th>
<th>DCB (n=15)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, years</strong></td>
<td>68 (±7,2)</td>
<td>73 (±7,7)</td>
<td>0,0785</td>
</tr>
<tr>
<td><strong>Male sex</strong></td>
<td>10 (67%)</td>
<td>9 (60%)</td>
<td>0,0679</td>
</tr>
<tr>
<td><strong>Body mass index, kg/m2</strong></td>
<td>29 (±5)</td>
<td>28,1 (±3,5)</td>
<td>0,6127</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>13 (87%)</td>
<td>15 (100%)</td>
<td>0,1432</td>
</tr>
<tr>
<td><strong>Coronary artery disease</strong></td>
<td>6 (40%)</td>
<td>7 (47%)</td>
<td>0,7125</td>
</tr>
<tr>
<td><strong>MI</strong></td>
<td>4 (27%)</td>
<td>3 (20%)</td>
<td>0,6600</td>
</tr>
<tr>
<td><strong>Atrial fibrillation</strong></td>
<td>0</td>
<td>3 (20%)</td>
<td>0,0679</td>
</tr>
<tr>
<td><strong>Hyperlipidemia</strong></td>
<td>14 (93%)</td>
<td>14 (93%)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Diabetes mellitus</strong></td>
<td>4 (27%)</td>
<td>7 (47%)</td>
<td>0,2557</td>
</tr>
<tr>
<td><strong>History of Stroke</strong></td>
<td>2 (13%)</td>
<td>4 (27%)</td>
<td>0,3613</td>
</tr>
<tr>
<td><strong>Chronic kidney disease</strong></td>
<td>2 (13%)</td>
<td>2 (13%)</td>
<td>1</td>
</tr>
<tr>
<td><strong>COPD</strong></td>
<td>3 (20%)</td>
<td>4 (27%)</td>
<td>0,6660</td>
</tr>
<tr>
<td><strong>Current Smoking</strong></td>
<td>10 (67%)</td>
<td>5 (33%)</td>
<td>0,0679</td>
</tr>
<tr>
<td><strong>Prior PTA last 3 month</strong></td>
<td>4 (27%)</td>
<td>3 (20%)</td>
<td>0,6600</td>
</tr>
<tr>
<td><strong>Prior peripheral bypass</strong></td>
<td>0</td>
<td>1 (7%)</td>
<td>0,3091</td>
</tr>
<tr>
<td><strong>Prior PCI</strong></td>
<td>7 (47%)</td>
<td>8 (53%)</td>
<td>0,7150</td>
</tr>
<tr>
<td><strong>Prior CABG</strong></td>
<td>1 (7%)</td>
<td>3 (20%)</td>
<td>0,2827</td>
</tr>
<tr>
<td><strong>Rutherford</strong></td>
<td><strong>1-3</strong></td>
<td><strong>12 (80%)</strong></td>
<td><strong>0,6242</strong></td>
</tr>
<tr>
<td></td>
<td><strong>4-6</strong></td>
<td><strong>3 (20%)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Rammos, VASA 2022
### The SAVioR trial – Results

#### Procedural Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Mechanical Atherothrombectomy + DCB (n=15)</th>
<th>DCB (n=15)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFP (µGy/m²)</td>
<td>1156 (±1315,7)</td>
<td>551 (±752)</td>
<td>0,1593</td>
</tr>
<tr>
<td>KM (ml)</td>
<td>114,8 (±61,8)</td>
<td>85,9 (±31,1)</td>
<td>0,0845</td>
</tr>
<tr>
<td>DLZ (min)</td>
<td>19,2 (±15)</td>
<td>10,9 (±8)</td>
<td>0,0814</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>4,7 (±0,6)</td>
<td>4,8 (±0,8)</td>
<td>0,8069</td>
</tr>
<tr>
<td>Lesion length (mm)</td>
<td>274 (±138,5)</td>
<td>155,3 (±71,6)</td>
<td>0,0081</td>
</tr>
<tr>
<td>De-novo restenosis</td>
<td>13 (87%)</td>
<td>12 (80%)</td>
<td>0,6242</td>
</tr>
<tr>
<td></td>
<td>2 (13%)</td>
<td>3 (20%)</td>
<td></td>
</tr>
<tr>
<td>Total occlusion</td>
<td>12 (80%)</td>
<td>5 (33%)</td>
<td>0,0099</td>
</tr>
<tr>
<td>Intervention with Stent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of stents</td>
<td>5 (33%)</td>
<td>4 (27%)</td>
<td>0,6903</td>
</tr>
<tr>
<td>Avg Length (mm)</td>
<td>120</td>
<td>80</td>
<td>0,3910</td>
</tr>
<tr>
<td>Intervention with DCB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of DCB</td>
<td>43</td>
<td>14 (93%)</td>
<td>0,3091</td>
</tr>
<tr>
<td>Avg Length (mm)</td>
<td>296</td>
<td>140</td>
<td>0,0007</td>
</tr>
<tr>
<td>TASC Femoral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1 (7%)</td>
<td>3 (20%)</td>
<td>0,2827</td>
</tr>
<tr>
<td>B</td>
<td>6 (40%)</td>
<td>6 (40%)</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>4 (27%)</td>
<td>4 (27%)</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>4 (27%)</td>
<td>2 (13%)</td>
<td>0,3613</td>
</tr>
</tbody>
</table>

Rammos, VASA 2022
The SAVioR trial – Results

Rotarex™S Debulking

- 100% Safety
- 100% Technical success
- 0% Distal embolization
- 0% MACCE or MALE
- 100% Primary Patency (6m)
The SAVioR trial – Results

Improved clinical (Rutherford) status

\[ <0.0001 \]

- Mechanical Atherothrombectomy + DCB
- DCB

- Worse
- Unchanged
- Improved

Rammos, VASA 2022
The SAVioR trial – Results

Mechanical Atherothrombectomy improves **target vessel** endothelial function

### Baseline vs. Acute vs. Follow-up

#### Mechanical Atherothrombectomy + DCB

- Baseline
- Acute
- Follow-up

#### DCB

- Baseline
- Acute
- Follow-up

* denotes p<0.05

Rammos, VASA 2022

**Mechanical Atherothrombectomy + DCB vs. DCB**

- Target limb FMD improvement (%)
- Baseline
- Acute
- Follow-up

* denotes p<0.05

© Universitätsmedizin Essen
Impact on **non-target vessel** endothelial function

---

**Mechanical Atherothrombectomy + DCB**

- **Baseline**: 
- **Acute**: 
- **Follow-up**: 

**DCB**

- **Baseline**: 
- **Acute**: 
- **Follow-up**: 

**Mechanical Atherothrombectomy + DCB vs. DCB**

- Non-target limb FMD improvement (%): 
  - Baseline: 
  - Acute: 
  - Follow-up:  

---

* denotes p<0.05

Rammos, VASA 2022
The SAVioR trial – Conclusions

- Study to investigate prognostic relevant outcome measures
- Mechanical Atherothrombectomy improves vascular function
- Impact on endothelial function through debulking
The SAVioR trial – Conclusions

- Study to investigate prognostic relevant outcome measures
- Mechanical Atherothrombectomy improves vascular function
- Impact on endothelial function through debulking

What is changing in the vessel to improve vascular function?
Contents

• Background
• SAVioR Trial - Endothelial Function
• SAVioR-IVUS Trial – Plaque Burden & Virtual Histology
• Conclusion
SAVioR-IVUS Trial

**Baseline**

**Mechanical Atherothrombectomy**

**DCB**

- Luminal gain
- Plaque burden
- Plaque composition

MATH. POBA and DCB

POBA and DCB

Rammus, VASA 2022
Mechanical Atherothrombectomy treatment

improves luminal area and luminal volume

* denotes p<0.05

Rammos, VASA 2022
Mechanical Atherothrombectomy treatment reduces plaque burden
Mechanical Atherothrombectomy treatment changes plaque composition and reduces calcium burden.

- Mean fibrous volume (mm³/mm)
  - Baseline: 9.0 (±1.5)
  - DCB: 6.5 (±1.5) * p<0.05

- Mean dense calcium volume (mm³/mm)
  - Baseline: 1.2 (±0.5)
  - DCB: 0.8 (±0.5) * p<0.05
  - Baseline: 1.2 (±0.5)
  - DCB: 1.2 (±0.5) ns
Conclusions

• Study to investigate prognostic relevant outcome measures
• Mechanical Atherothrombectomy improves vascular function
• Impact on endothelial function through debulking

• Change in plaque burden, luminal gain and calcium removal through Mechanical Atherothrombectomy
• Potential prognostic implications for PAD
Rotarex™ S Catheter

Indications
Rotarex™S catheters in combination with the Straub Medical Drive System (REF SRS-Set/80300) are intended for the percutaneous transluminal removal of thrombotic, thromboembolic and atherothrombotic material from fresh, subacute and chronic occlusions of blood vessels outside the cardiopulmonary, coronary and cerebral circulations; Indicated for Native blood vessels or vessels fitted with stents, stent grafts or native or artificial bypasses outside the cardiopulmonary, coronary and cerebral circulations.

Contraindications
Patients not suitable for thrombectomy. Vessels of the cardiopulmonary, coronary or cerebral circulations; undersized or oversized vessel diameters; subintimal position of the guidewire – even if only in short segments; use in stents, stent grafts, or vena cava filters if the guidewire has become threaded at any point in the wire mesh / construction of stent, stent graft or the lining of the stent graft; if the introducer sheath, the guide catheter, the guidewire or the Rotarex™ catheter sustains any damage, especially kinking; in the fracture areas of broken stents; if used inside or via narrow vessel radii or in tortuous vessel courses (radius of curvature < 2 cm); in severely calcified vessel segments; in aneurysmatically altered vessel segments; in veins; if it is impossible to achieve sufficient anticoagulation and platelet aggregation inhibition.

Warnings
Before using the Straub Endovascular System and its components, the user must be entirely familiar with the user manuals and the instruction of use. The catheter must be straightened at all times, or if the outlet tube does not run vertically and completely stretched from the base of the catheter to the introducer sheath. Do not use the catheter if the guidewire has become threaded at any point in the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip. Do not use the catheter if the guidewire has become threaded into the wire mesh of stent or stent graft or the lining of the stent graft. Do not operate the catheter in the fracture areas of broken stents or stent grafts, despite correct positioning of the guidewire. Monitor the correct position of the guidewire throughout the entire process of catheter use. The catheter must never be kinked at any stage. If no light is visible in the introducer sheath, the guide catheter must be repositioned according to the instructions for use. Make sure that the flexible tip of the guidewire is placed as distal as possible to the introduced segment to prevent the flexible tip from being aspirated into the catheter head. The catheter must lie inside the lumen throughout its course from the introducing sheath to its flexible tip.

Precautions
The internal lumen of the introducer sheath must at least correspond to the external diameter of the catheter. At all times monitor the quality of blood transported into the collecting bag. Effective anticoagulants at a suitable dose have to be administered before the patient is treated with the Straub Endovascular System in order to achieve an activated clotting time (ACT) > 250 seconds or equivalent values according to other measuring techniques, throughout use of the catheter. If used correctly, embolizations caused by material detached by the catheter head are very rare. Ensure that the catheter lumen is completely filled with solution when the motor is running. The wire adapter must be in the working position (knob pulled out) during use of the catheter; If there is unlikely to be enough natural flow of blood to the catheter head, the supply of liquid to the catheter head can be guaranteed by providing additional appropriate liquid, such as isotonic saline, via a suitable access, such as the side-port of the introducer sheath being used. If the LEDs go out or the alarm is audible, safe functioning of the catheter is no longer guaranteed. If the activated motor is not kept at the same height as the introducer sheath, or if the section of the catheter located outside the patient's body is not completely straightened at all times, or if the outlet tube does not run vertically and completely stretched from the catheter into the collecting bag, technical problems such as blockage of the catheter, helix fracture or guidewire fracture may occur; Blood and thrombus fragments in the catheter lumen might clot if the helix has stopped. Therefore, if catheter use is interrupted, the catheter must be rinsed immediately in heparinized isotonic saline.

Potential Adverse Events
Embolisms, especially distal thromboembolisms; pulmonary embolisms of all degrees of severity; thromboses, especially recurrent thromboses; re-oclusion; vessel wall injury or valve damage; vessel dissection / perforation / rupture; perforation as a result of catheter and/or guidewire: debris remaining in the body; allergic reactions to catheter material; death; infections or necrosis at the puncture site; allergic reactions; catheter-induced sepsis.

Please consult product labels and instructions for use for indications, contraindications, hazards, warnings, and precautions. Not all products, services or features of products may be available in your local area. Please check with your local BD Representative. This is intended for Health Care Professionals only. BD Switzerland Sarl, Terre Bonne Park – A4, Route De Crassier, 17, 1262 Eysins, Vaud. Switzerland © 2023 BD, BD logo, and Rotarex are trademarks of Becton, Dickinson and Company or an affiliate. Illustrations by Mike Austin. All Rights Reserved. BD-87808