The role of Multilayer Stents in Dissections and Penetrating Ulcers

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Uei Pua Singapore
Conflict of Interest

None
Flow diverters - where to use

Bowen Jiang et al. Stroke Vasc Neurol 2016;svn-2016-000027
Preventing Aneurysm Rupture

It is all about Reduction of Shear Stress!

Peak Wall Shear Stress (\(=\) highest value)

The only reliable predictor for aneurysm rupture risk evaluation

All About Reducing Peak Wall Shear Stress

\[ W/O \text{ MFM}^\circ \]

\[ \sigma_m = \text{Main stress} \]
\[ \sigma_r = \text{Radial stress} \]

\[ \sigma_l = \text{Longitudinal stress} \]

\[ \sigma_r = 3P \approx 0 \]
\[ \sigma_m \approx \sigma_l \]

Remove the risk of Expansion and rupture

WSS distributions on the sac wall at different time frames

4. Z Hooshyar et al., JBiSE 7 (2014) 848-855
Bernoulli's Principle

The Swiss Physicist Daniel Bernoulli, was interested in how the velocity changes as the fluid moves through a pipe of different area. He especially wanted to incorporate pressure in his idea as well. Conceptually, his principle is stated as: "If the velocity of a fluid increases, the pressure decreases and vice versa."
The Concept
Aneurysm w/o branches \textit{in vitro} PVI study

\begin{itemize}
  \item Endothelial cells stop at the edge of branches
\end{itemize}

Animal Study (Dr Bonneau, INRA & NAMSA, France)
Without MFM

With MFM

+20%

Dr Diethrich, Phoenix Az.
Type B Dissection: Re Expansion of true lumen
Example of Lumbar Perfusion
Patient DA_040_001 - 3D

28 Years Old Female Patient with Type B Dissection

Courtesy by Dr Kostache
False Lumen AA after Type B Dissection

Contraindication:

Branches arising from False Lumen:

55% Pressure drop in visceral arteries when supplied by false lumen

Vascular Centre Catholic Hospital Group Duesseldorf
Augusta Hospital
Lumbar Perfusion preserved avoiding Paraplegia.
Contra indication - Type A Dissection ??
Type A Dissection Clamp related after CABG
When there is no time for Chimneys

Type B Dissection, Rupture, Retrograde Type A Dissection
Combining Flow Modulation with Fenestrated Graft
78 year old female Patient
Acute Ischemia left leg

True lumen Collaps
Re Expansion True Lumen
Acute Type B Dissection. Persistent Symptoms after 1 week. 74 year old female Patient

Placement of Lunderquist Wire and Angiography
Retrograde Type A Dissection - False Lumen

True Lumen: Occlusion of all Supraaortic Vessels
Transbrachial Approach: Salvage with MFM Stents as a Bridging Procedure for Aortic arch Replacement
Stability in the Arch
PAU

TAA_049_009

Pre-Implantation PAU at the level of Left Subclavia’s origin (with dissected flap)

Follow-Up at 7 Months

<table>
<thead>
<tr>
<th>TAA_049_009</th>
<th>PRE</th>
<th>M07</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>D1</td>
<td>D2</td>
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<tr>
<td>Lesion Diameters (mm)</td>
<td>45,6</td>
<td>36,2</td>
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Follow-Up at 7 Months
Intercostal Patency – 3D Reconstruction
CFD_049_117

PRE-Implantation PAU at the level of Celiac Trunk’s origin

Follow-Up at 3 Days

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<td>40.75</td>
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Female – 85y old
Patient included in the Strato Trial

Priors:
Coronary Artery Disease;
Previous PCI;
Cardiac Arrhythmia (Atrial Fibrillation);
Hypertension;
Hyperlipidemia;
Diabetes Mellitus;
Peripheral Arterial Disease;
Pulmonary Embolism;
Cholecystectomy.

Pathology:
PAU at the level of T8 Vertebra.

MFM® Information: CTMS 30150 - Generation 1

Follow-Up: 24 Months
Pre-Implantation

Follow-Up at 24 Months

<table>
<thead>
<tr>
<th>Lesion Diameters (mm)</th>
<th>D1</th>
<th>D2</th>
<th>D1</th>
<th>D2</th>
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<tr>
<td></td>
<td>82.86</td>
<td>53.76</td>
<td>81</td>
<td>55.35</td>
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</table>
At 32 Months:
- Near complete PAU exclusion;
- Patency of the covered Aortic Arch branches: BCT, Primary Left Carotid and Left Subclavia.
Computational fluid analysis of symptomatic chronic type B aortic dissections managed with the Streamliner Multilayer Flow Modulator

Florian Stefanov, PhD, Sherif Sultan, MD, FRCSI, FACS, EBQS Vasc, Liam Morris, PhD, Ala Elhelali, Edel P. Kavanagh, PhD, Violet Lundon, Mohamed Sultan, BSc, and Niamh Hynes, MB, BCh, BAO, MRCS, MMSc, MD

Galway, Ireland

Results: At 1-year follow-up, the true lumen volume increased from $175.74 \pm 98.83 \text{ cm}^3$ to $209.87 \pm 128.79 \text{ cm}^3$; the false lumen decreased from $135.2 \pm 92.03 \text{ cm}^3$ to $123.19 \pm 110.11 \text{ cm}^3$. The false lumen index decreased from $0.29 \pm 0.13$ (preoperatively) to $0.21 \pm 0.15$ (postoperatively). The primary SMFM treatment of SCTBAD increased carotid perfusion by $35\% \pm 21\% (P = .0216)$ and suprarenal perfusion by $78\% \pm 32\% (P = .001)$. The wall pressure distribution blended along the newly enlarged true lumen, whereas the false lumen wall pressure decreased by $6.23\% \pm 4.81\%$ for the primary group (cases 1-7) and by $3.84\% \pm 2.59\%$ for the secondary group (cases 8-12).

Conclusions: SMFM provides a promising tool for the treatment of chronic type B aortic dissection. It achieves patency of all branches, minimizing the incidence of late dissection. SMFM is a feasible option for managing primary SCTBAD, without midterm complications.

Problem: 12 cases only
### Penetrating Aortic Ulcer  \( n = 24 \)

<table>
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<th>Age</th>
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<tr>
<td>TAA_057_001</td>
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### Lesion Exclusion

- Near complete: All patent
- Partial: All patent
- Complete: All patent
- Near complete: N.A.

### Covered Branch Patency

- Near complete: All patent
- Partial: All patent
- Complete: All patent
- Complete Resolution: All patent
- Near complete: All patent
- Partial: N.A.

### Follow up

- Mean age: 68 Years - mean follow up 17,6 months
- 21 Patients
- Stable: 80 %
- Reduction: 10 %
- Thrombus Volume Increase: 14 %
- Branch Patency: 100 %
- Follow up (mean): 18 (1 - 80)
When the MFM May Not Be Effective:

- **Due to Technical Errors**

  Lack of sufficient **proximal and distal healthy zone** to avoid peri-MFM leak (it needs at least 2cm for enough sealed wall apposition)

  Lack of **sufficient overlapping**; It needs at least 3cm. (overlapping in front of the branches does not effect the lamination of the flow)

  The large size must be inserted in the small one to avoid endoleak type III

  **Stenosed branches** must be treated prior to MFM deployment
CONTRAINdications

- Ruptured Aneurysm
- Shaggy Aorta
- Takayasu’s Arteritis
- Arterio-venous fistula
- Porcellaine Aorta
- Diameter > 6.5 cm
Outside of IFU

Unsafe at any speed
Conclusion: The effects of Flow Modulation in Acute Dissections and PAU

- Aortic Remodeling
- False Lumen Reduction
- Preservation of Branches
- Avoiding Paraplegia

To be continued - more data are required
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