Histopathologic findings in patients and animals after implantation of MFM®: characteristics of endothelialization and thrombus formation

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Background

» A new expandable mesh (Multilayer Flow Modulator-MFM®) was designed for endoluminal repair of aneurysm through hemodynamics and physiologic principles

» This 3D porous fabric mesh was designed to offer a compliant curvature, flexibility, to withstand deformation and to reduce complications

Preclinical models

» A porcine vein pouch model was used to determine:
  - Deployment ability and mesh stability,
  - Concept of aneurysm physiological exclusion,
  - Side branch patency,
  - Integration, endothelialization kinetics (up to 6 months), and vascular response.

» A rabbit elastase aneurysmal model was used to study the healing process

» Aortic, Peripheral and Intracranial implantations evaluation

Study Objective

» The preclinical animal studies reported aimed to determine the biological sequence of events leading to aneurysm repair without device failure (histologic proofs)

» 2 clinical cases are reported verifying the preclinical findings

Patients

» Male 44 y.o., TAAA case, (Dr Barchiche (Belgium)).
  - Multiple aneurysms, two MFMs implanted
  - Implantation duration: 10 months (explantation, died, suspicion of infection)

» Male 78 y.o., Renal case (Dr Polydorou & Dr Henry – (Greece)
  - Renal saccular aneurysm,
  - Hypertensive with multiple comorbidities, smoker,
  - Implantation duration: 30 months (unrelated death (cancer))
Methods

The investigation methods used to study the mechanistic process leading to aneurysm repair were:

- Imaging
- Resin Histology,
- Immunohistochemistry
- Ultrastructural analysis (Scanning Electron Microscopy-SEM)

Results 1: Preclinical Outcomes

- The MFM® successfully deployed and remained stable: no kinking, migration, collapse, fracture, endoleak or complications
- Reduction and aneurysm exclusion with repair through remodeling

*Thrombus showing laminations (lines of Zahn)*

- Lines of Zahn = high velocity blood flow + lamination.
- Lee R et al; *Eur Heart J*, 2012

Results 1: Preclinical Outcomes

- Turbulent blood flow laminated with promotion of physiological thrombus (Lines of Zahn Explanation)

- Vascular integration with preservation of all types of side branches

Results 1: Preclinical Outcomes

- Endothelialization and limited signs of neointimal hyperplasia and local inflammation

- Marked signs of infection unrelated to the device

Results 2: Clinical Outcomes

- TAAA Case (Dr. Barchiche, Belgium):
  - Vascular integration despite a very thin aorta wall
  - Reinforcement of the vascular wall despite a poor collagen content
  - Presence of all visceral branches
  - Marked signs of infection unrelated to the device
Results 3: Clinical Outcomes

Renal Case (Dr. Polydorou & Dr. Henry, Greece):
- Healing with tripling of the aneurysmal wall
- Complete vascular integration, no dilation nor leakage
- Preservation of branches

L. Renal Saccular Aneurysm (IO): Angiographic views

Results 3: Clinical Outcomes

Renal Saccular Aneurysm (F-Up) – CT Scan / 3D reconstruction

Results 3: Clinical Outcomes /Histology

Conclusion

- In animal models, neither adverse effects nor complications were observed with the MFM®
- It remains mechanically stable over time with an adequate conformability in human and animal
- Sequential events of repair with histology proofs:
  1. Reduction of wall shear stress (lamination),
  2. Thrombus formation and Exclusion
  3. Integration, endothelialization and aneurysm repair (side branches preserved)

Thank you