Vascular Access:
A-V Grafts and Materials

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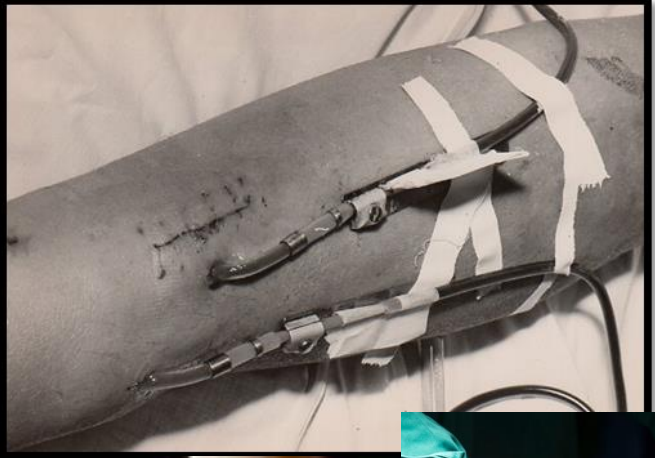
Disclosures

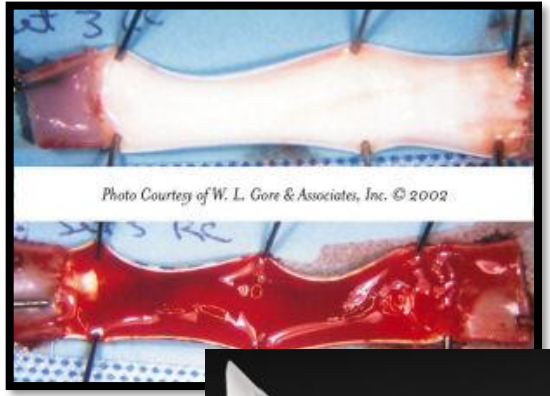
Consulting, Clinical Trials and Opinion

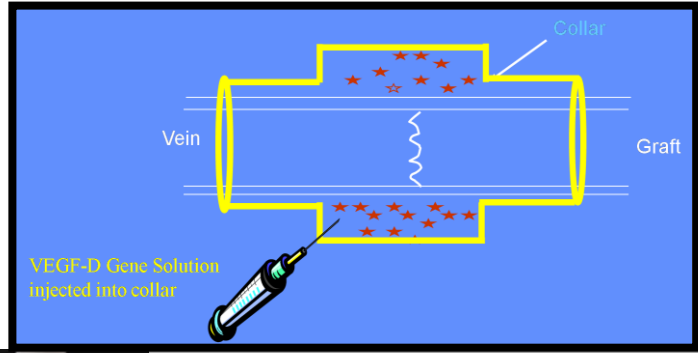
Cryolife
Baxter
Lemaitre
Johnson & Johnson/Ethicon
Endologix
Zymogenetics
W.L. Gore
Atrium Medical
Humacyte
C.R. Bard
InnAVasc

Research

American Heart
ACS
NIH
ADA
HHMI
DOD



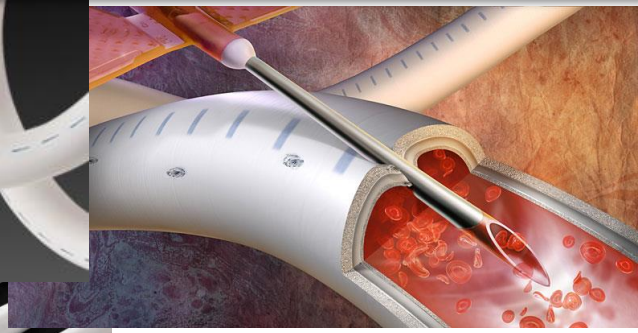

Photo Courtesy of W. L. Gore & Associates, Inc. © 2002


Collar
Vein
Graft
VEGF-D Gene Solution
injected into collar



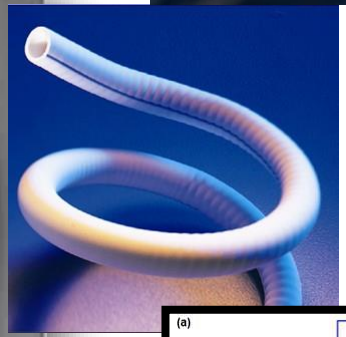


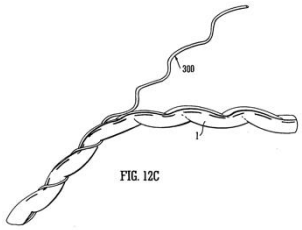

ATRIUM



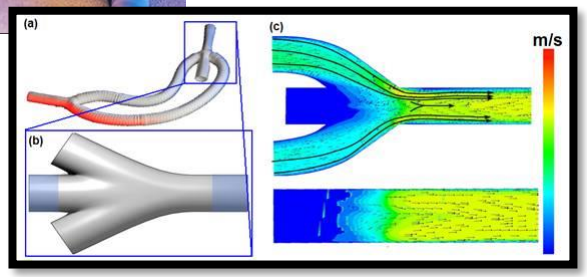


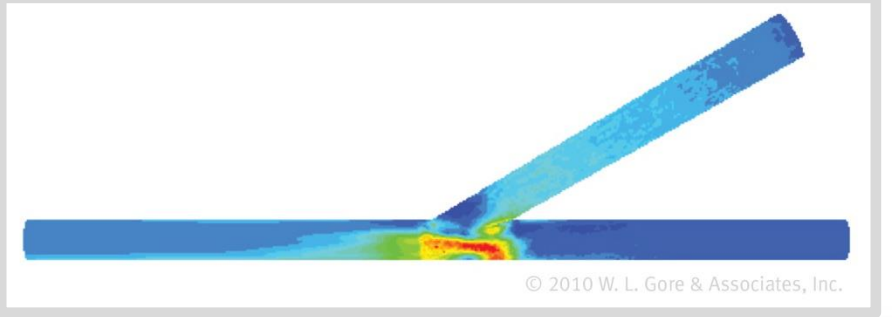





300
1
FIG. 12C

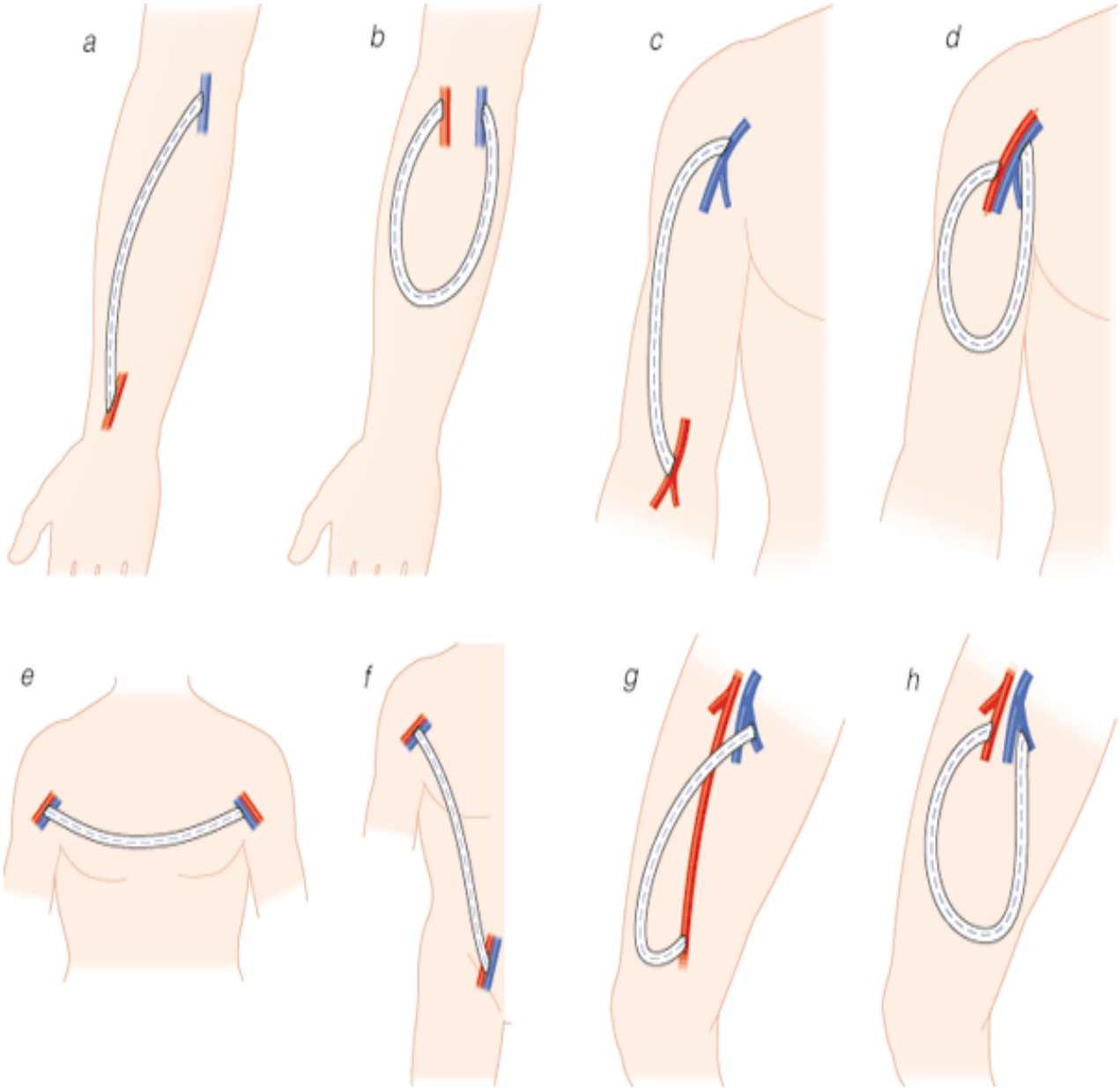
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(a)
(b)
(c)
m/s


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INNAVASC

Access options for AVG



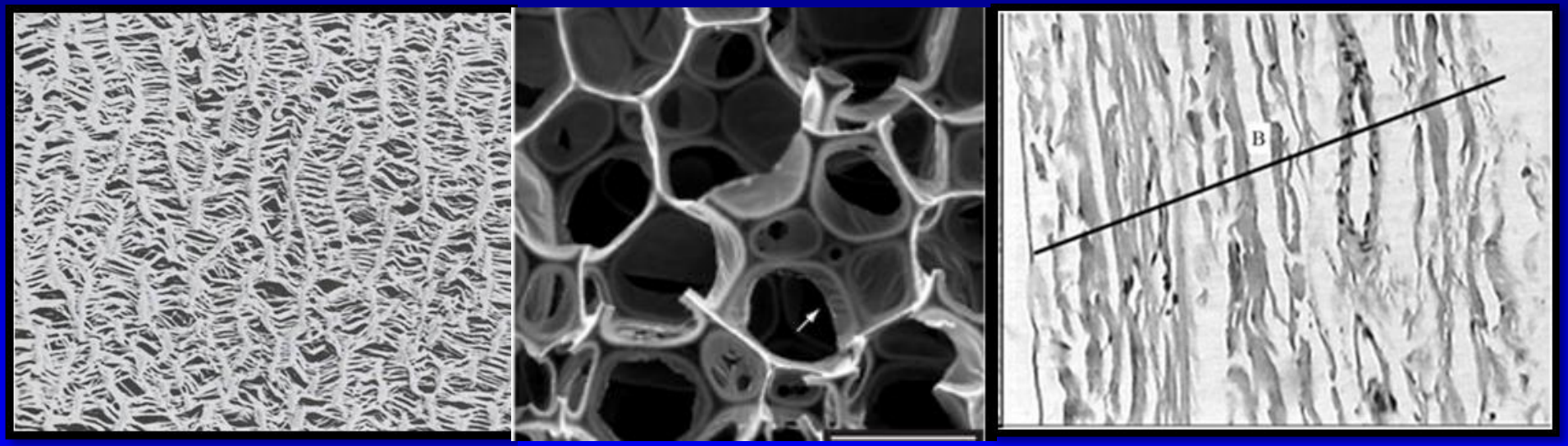
AV Graft Placement – Any stickable place that connects an Artery to a Vein



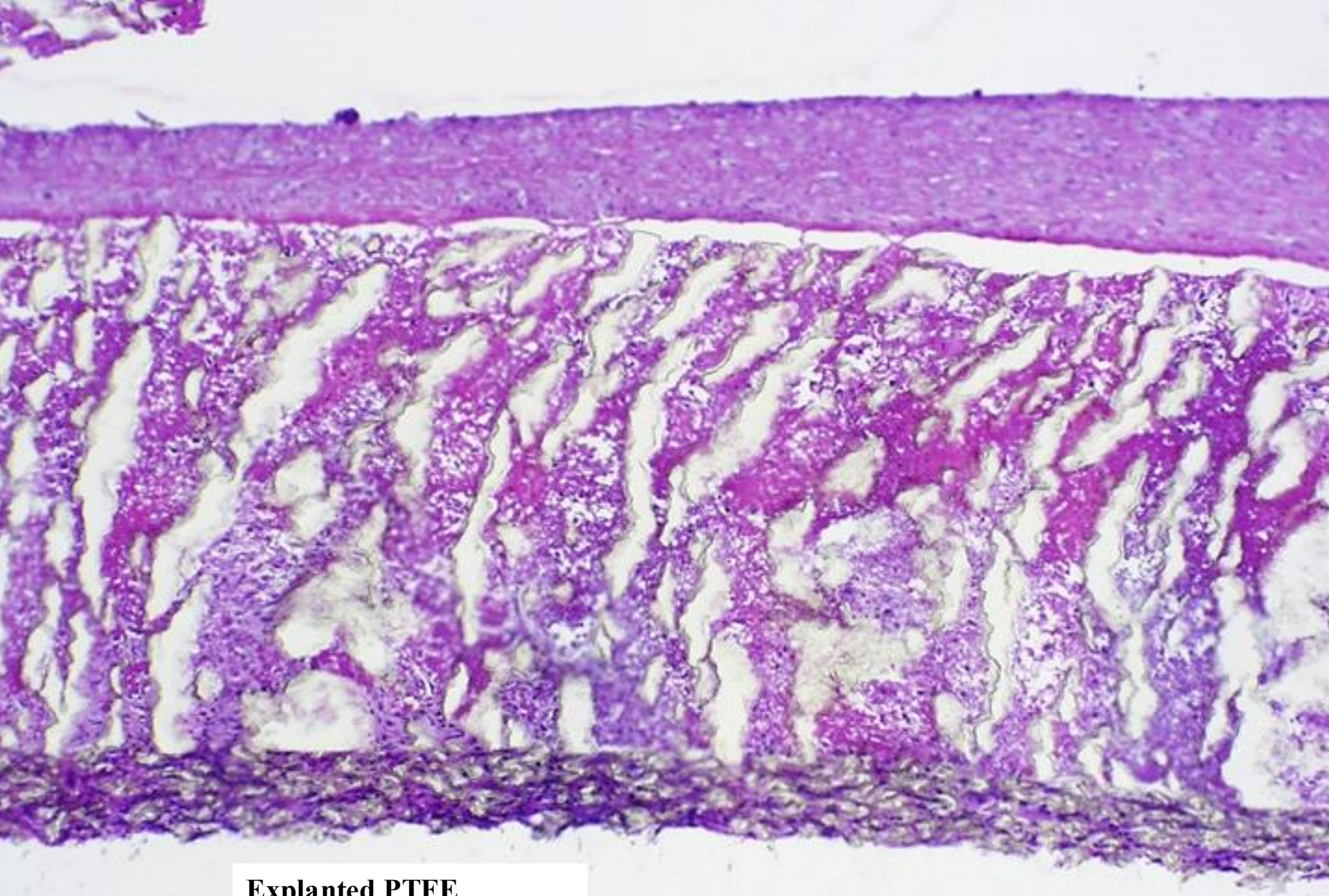
Figure 16: Various AVG insertion sites and configurations (A) Ax-Ax teardrop (B) Ax-Ax chestwall loop (C) Femoral SFA to CFV (D) Upper arm brachial artery to axillary vein.

AV Graft Materials

ePTFE Polyetherurethaneurea Bovine vein



Graft Material….does it matter???



Explanted PTFE
Mag x10

Physiologic Effect of AVG

- Average Flow of newly implanted AVG between 800 and 1500 ml/min
- Immediate high-flow shunt between left and right heart
- Proximal grafts (subclavian and femoral) may have flow > 2000 ml/min
- Chronic stress on cardiac output can lead to both left and right side heart failure
- Graft infection can result in cardiac valve infection

US Vascular Access Problems

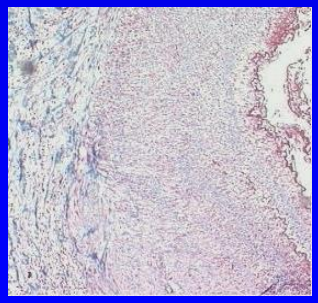
AV Grafts

- Poor long-term patency
  - Vein neointimal hyperplasia
  - Stenosis
  - Thrombosis
  - Graft infections
  - Graft wall deterioration/abuse
- DAC study indicated loss of patency in 75% of AVGs at one year[2]









[2]Dixon et al. N Engl J Med 2009;360:2191-201.

Why do Graft Fail?

Bleeding

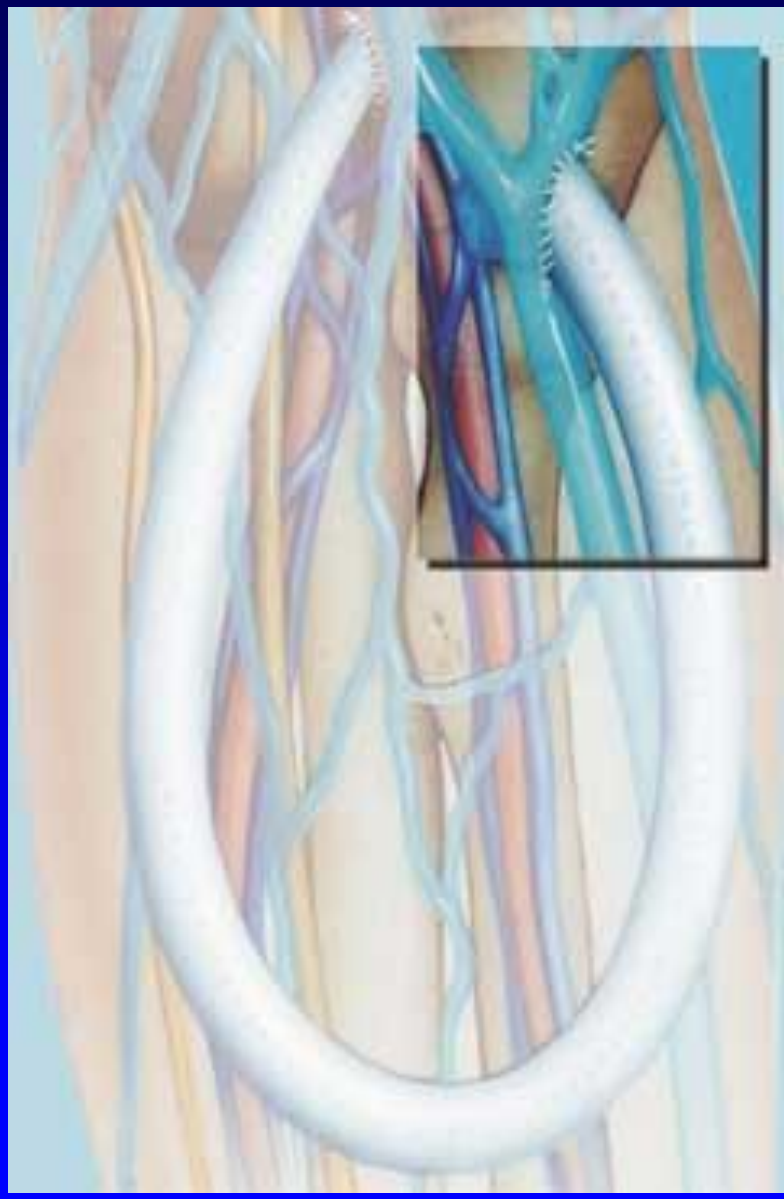
Thrombosis

Proliferation

Physiology

Infection

Abuse



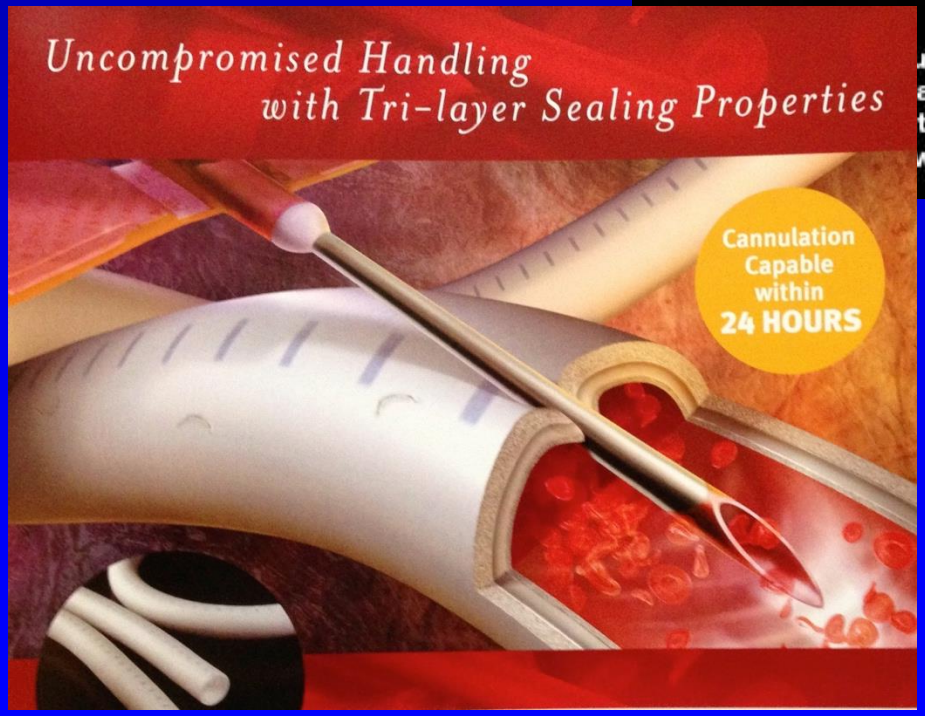
Early Cannulation Grafts

Bleeding/Weeping

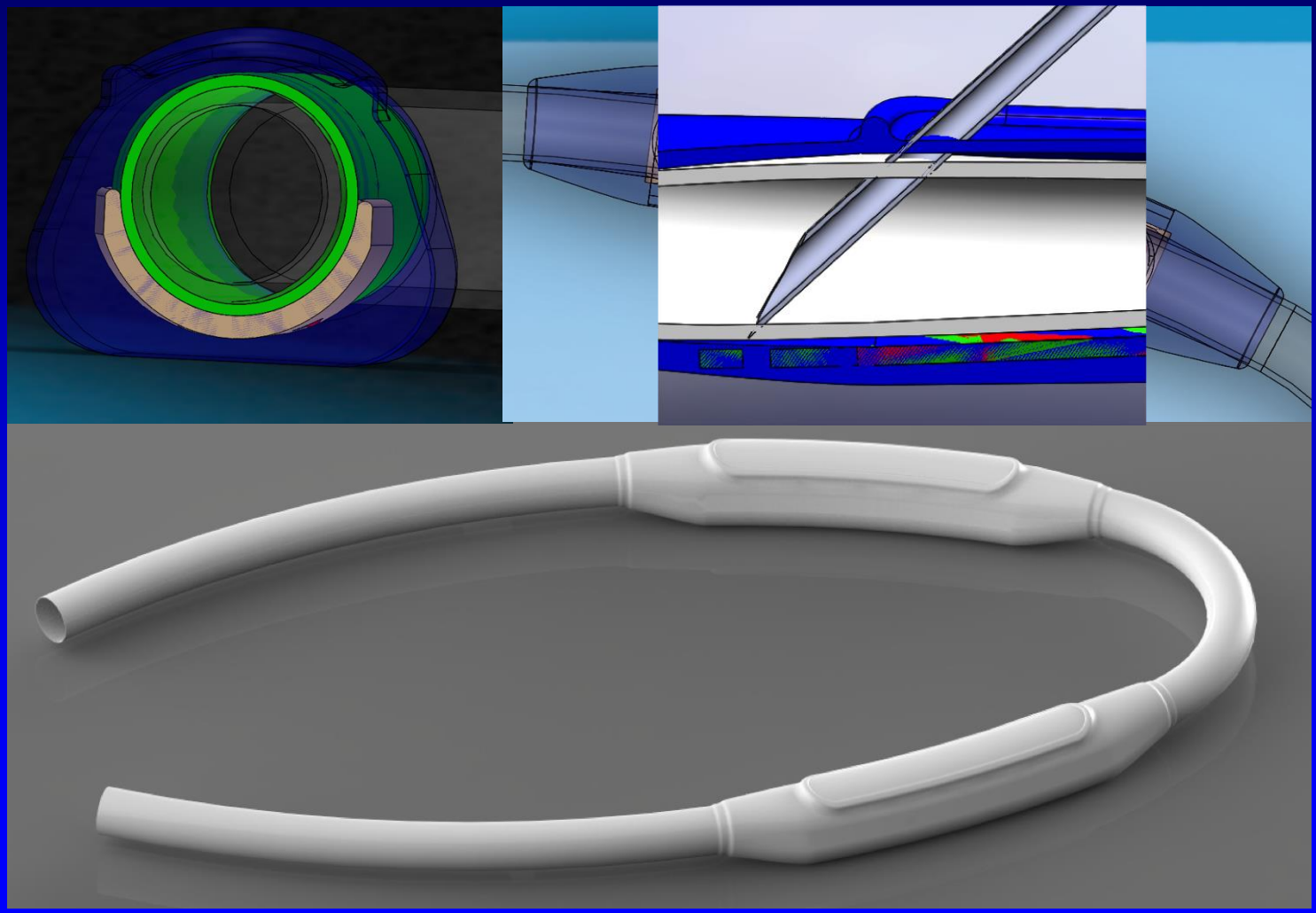
Needle Stick Sealing Grafts

Vectra
Expedial
Vascutek
Flixene
Acuseal





InnAVasc



Thromboresistant Grafts

Bleeding

Thrombosis

The Development of Heparin Coated ePTFE

Thromboresistant Luminal Graft Surface



GORE PROPATEN Vascular Graft: Bioactive Surface

- Free of thrombus



Control Graft: Non-Bioactive Surface

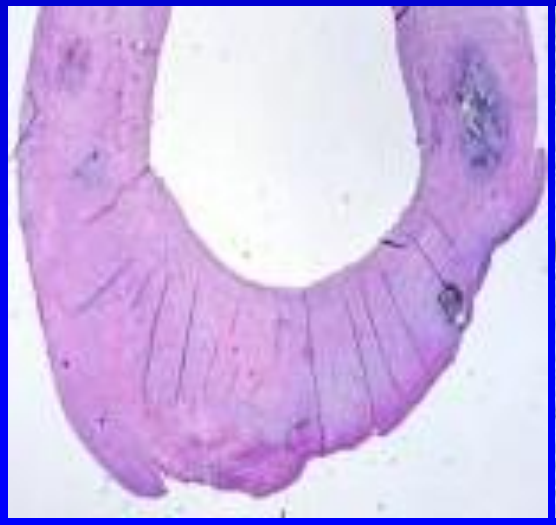
- Covered with thrombus

Experimental Work to Improve Grafts

Bleeding

Thrombosis

Proliferation



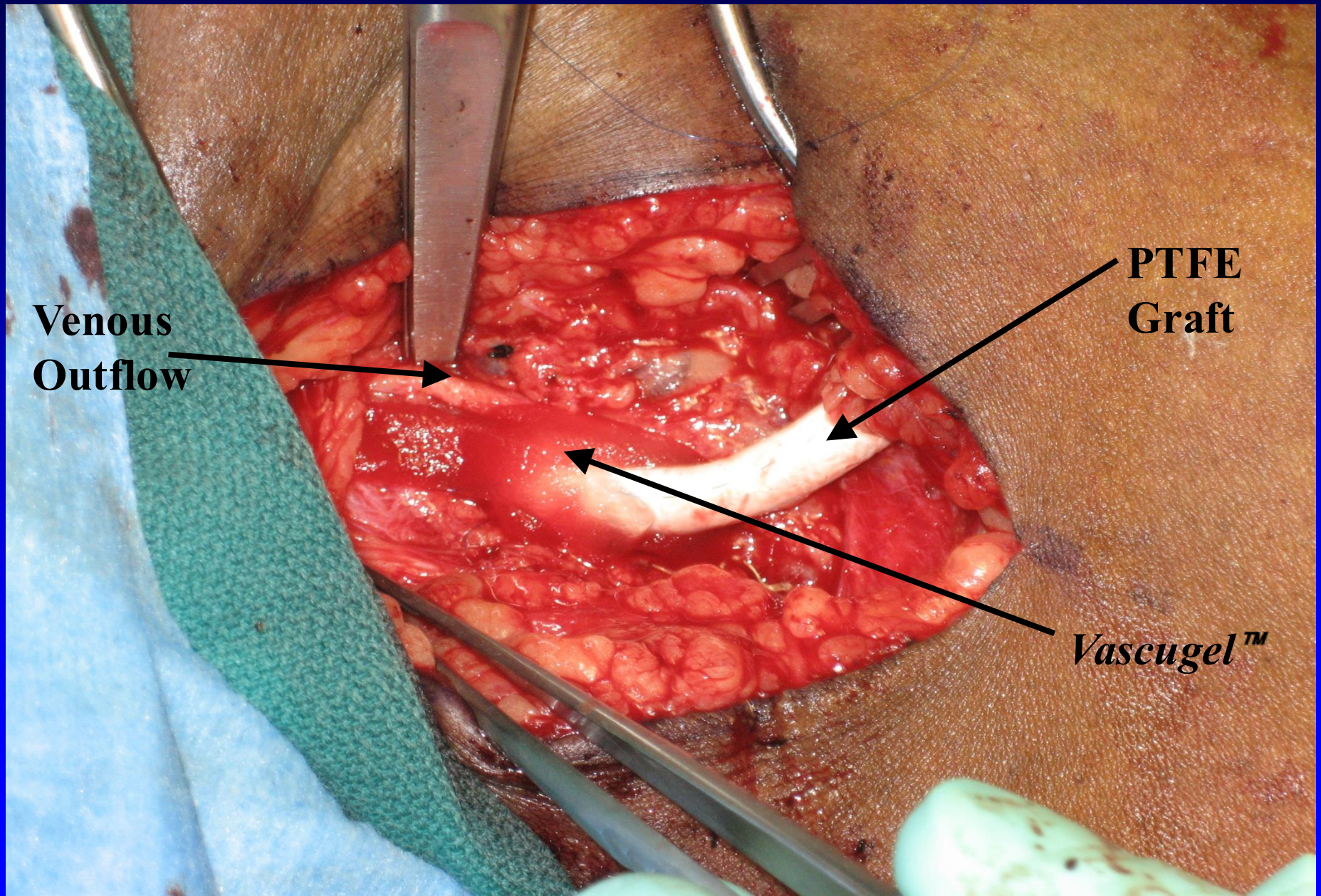


Changes in Graft Compliance

Alterations in Anastomotic Biology of the Vein

Gene Therapy
Cell Therapy
Anti-Proliferative Drugs

Endothelial "Cell Therapy"- Arteriovenous Graft



Grafts Physiology and Hemodynamics

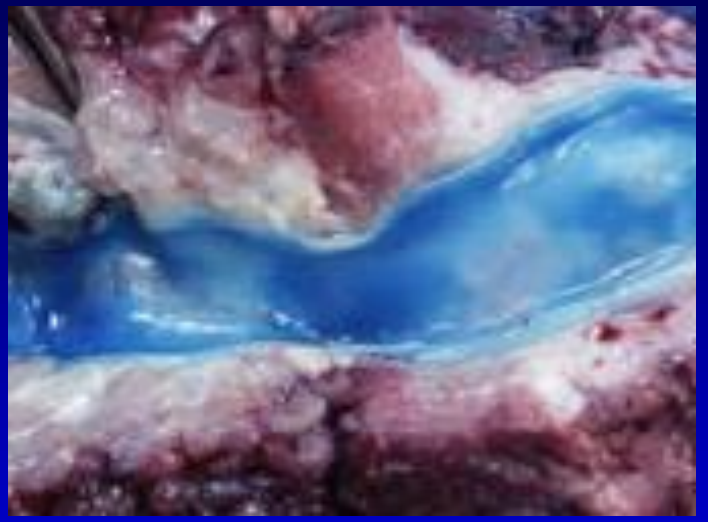
Bleeding

Thrombosis

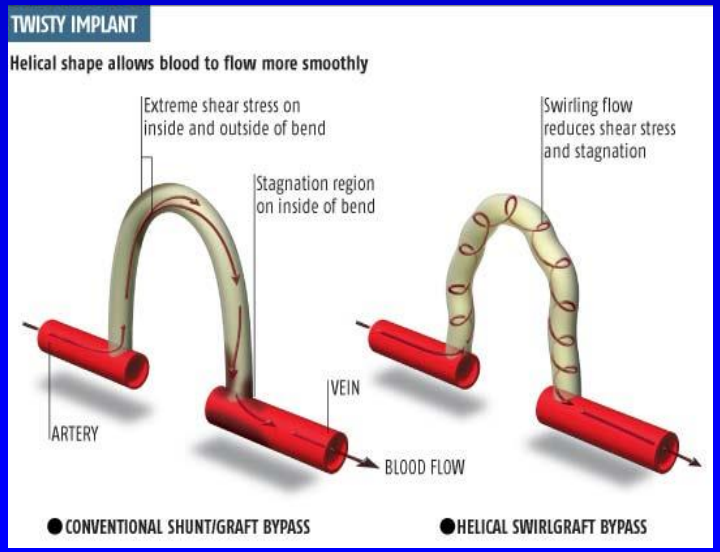
Proliferation

Physiology

Cell Seeding



Graft Flow Hemodynamics

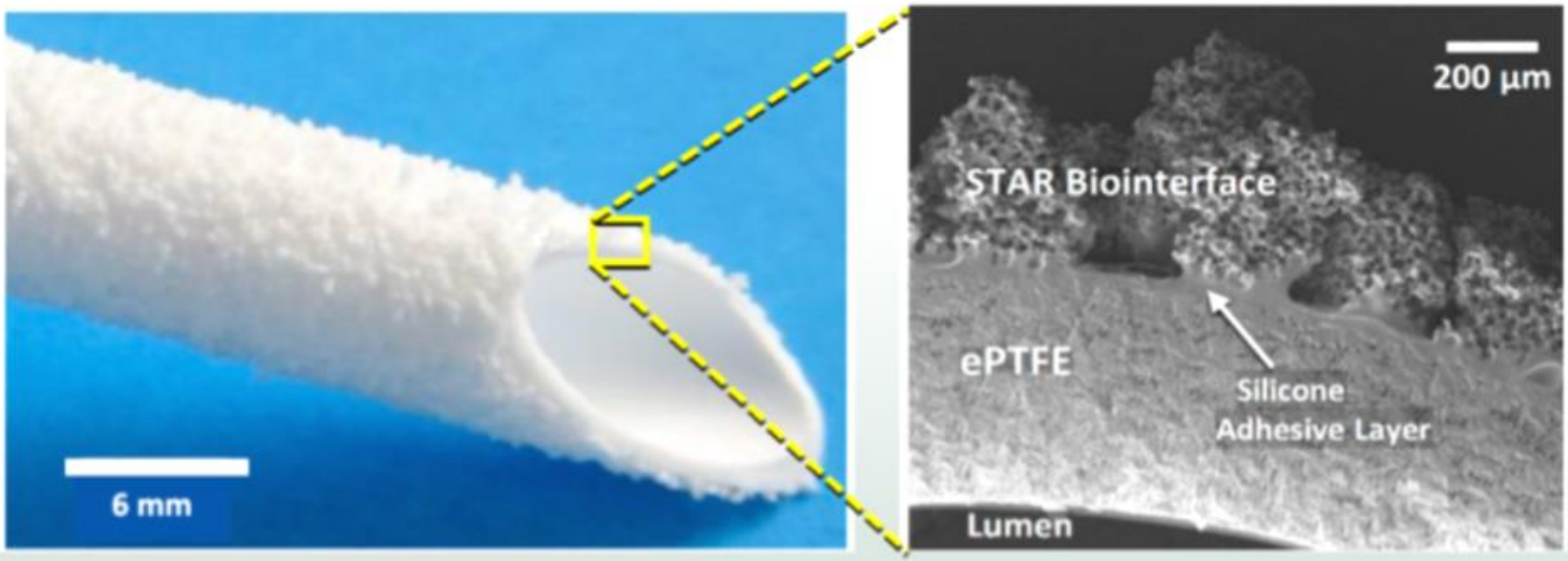


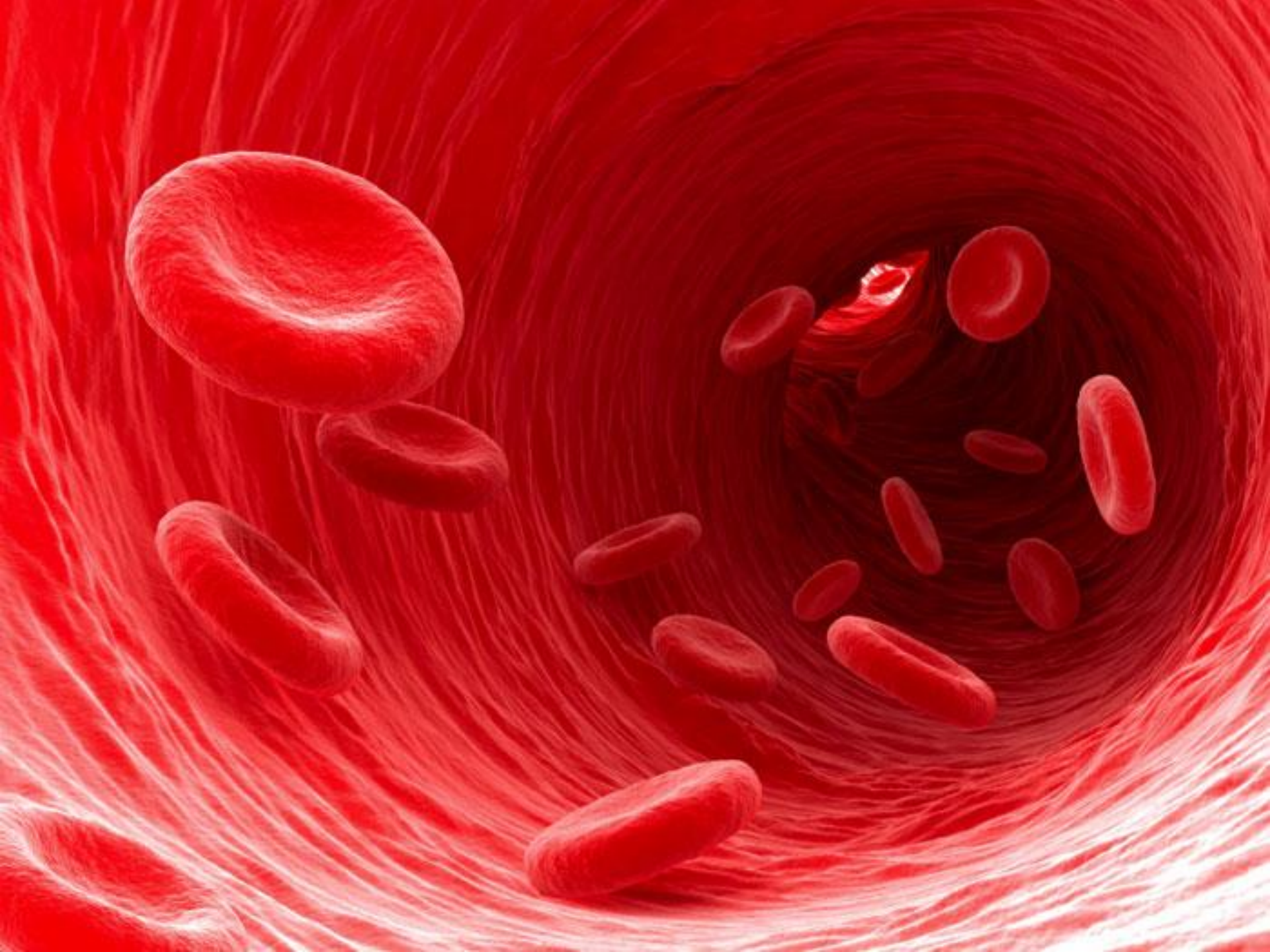
Outflow Hemodynamics



STAR Graft

Conventional Synthetic Materials: ePTFE structural core is **externally** coated with a novel biointerface layer of soft porous silicone granules.

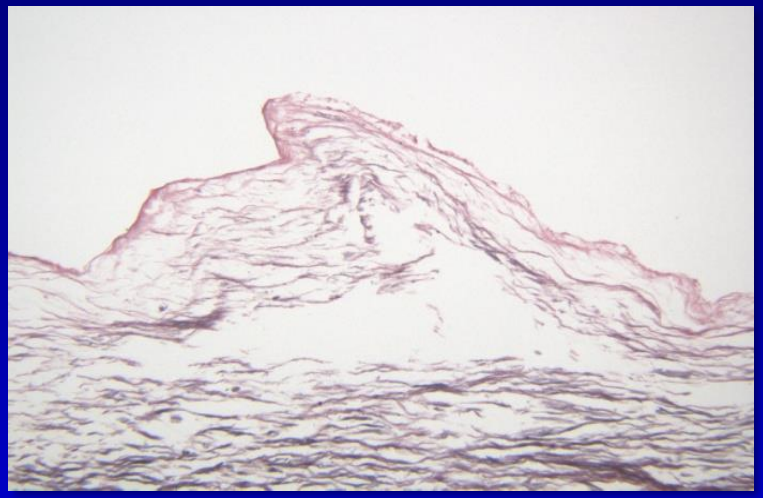




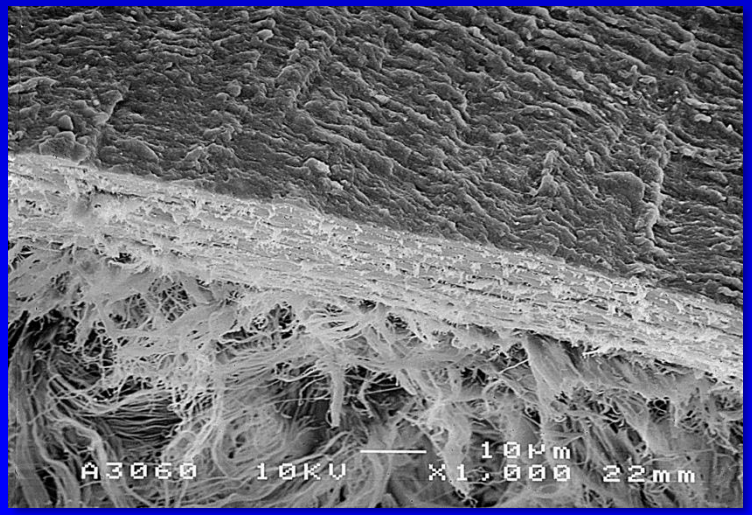
Xenograft Morphology

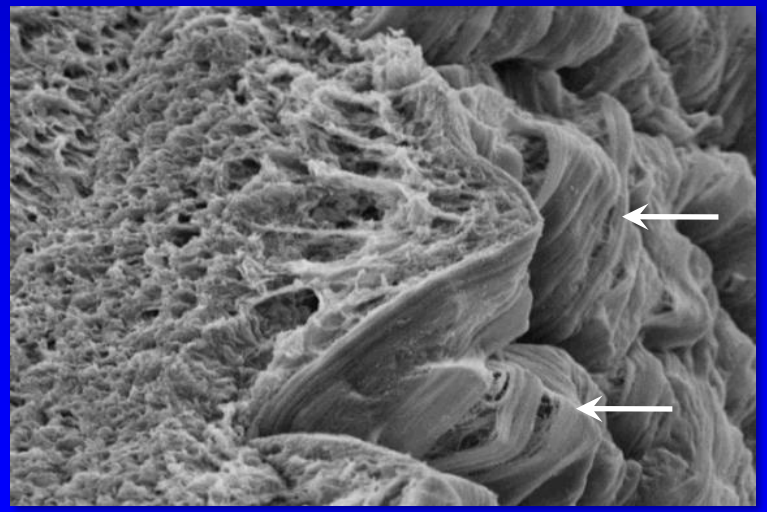


ProCol

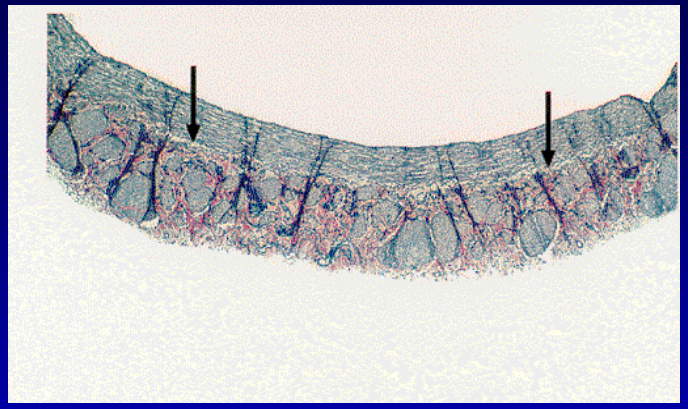


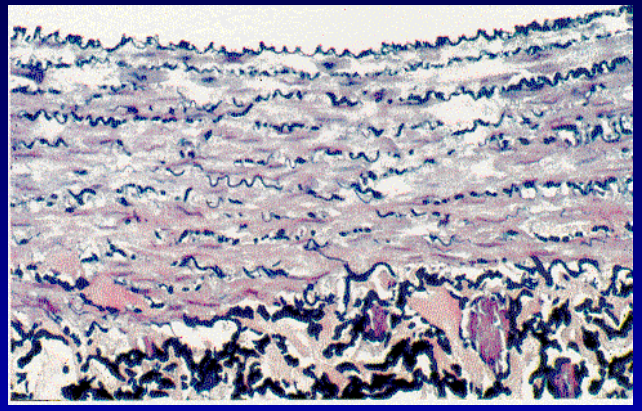
Artegraft

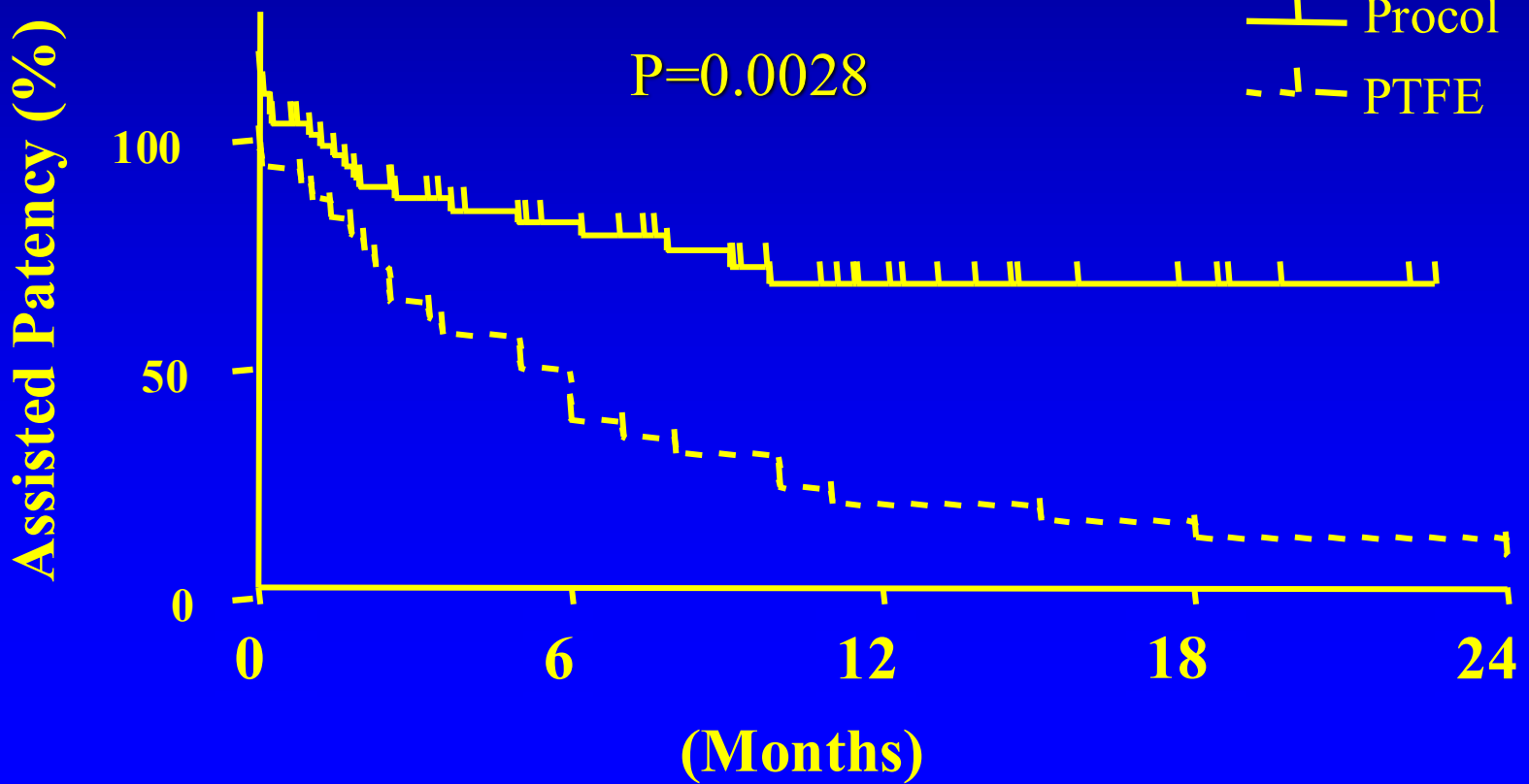




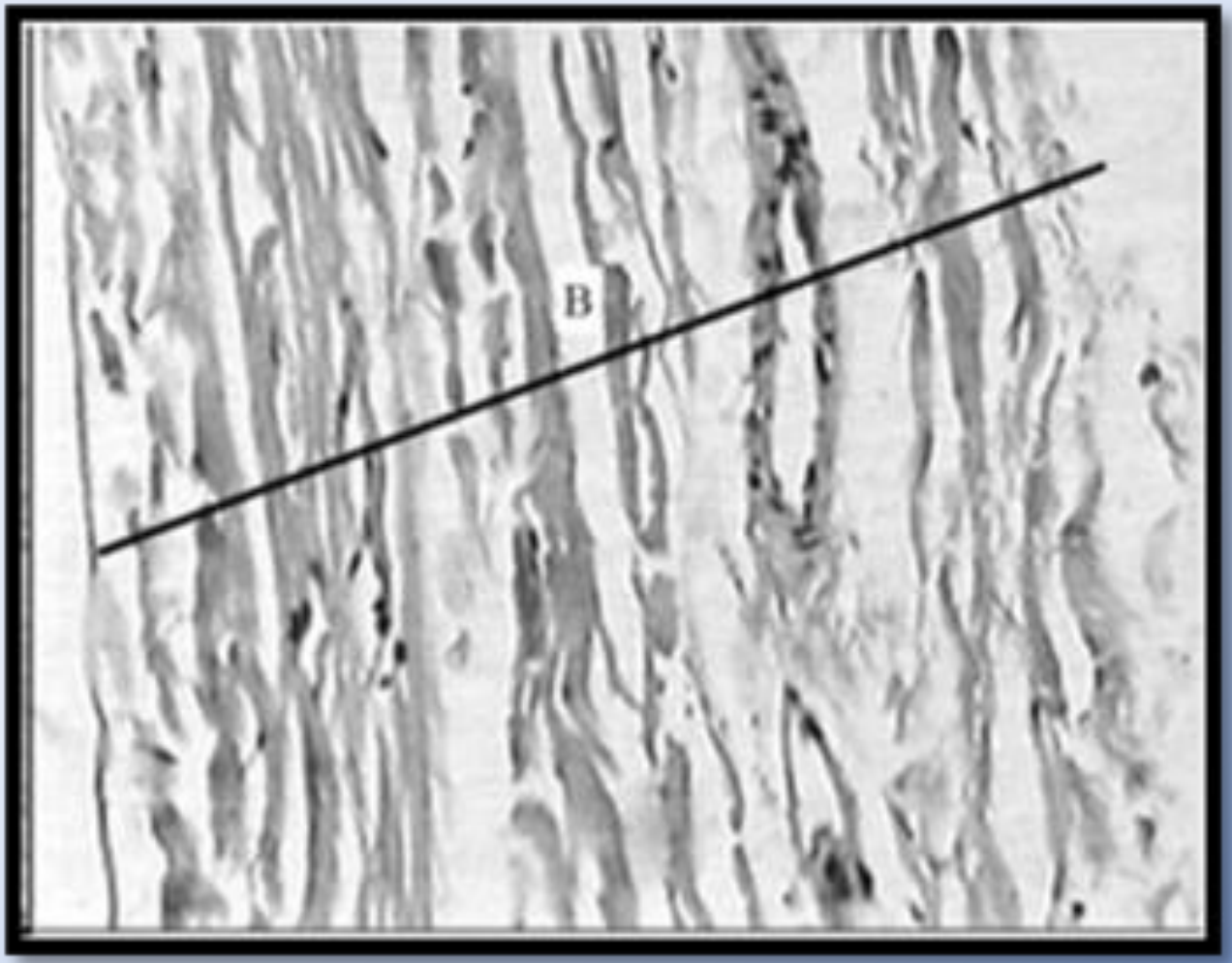
Graft Compliance







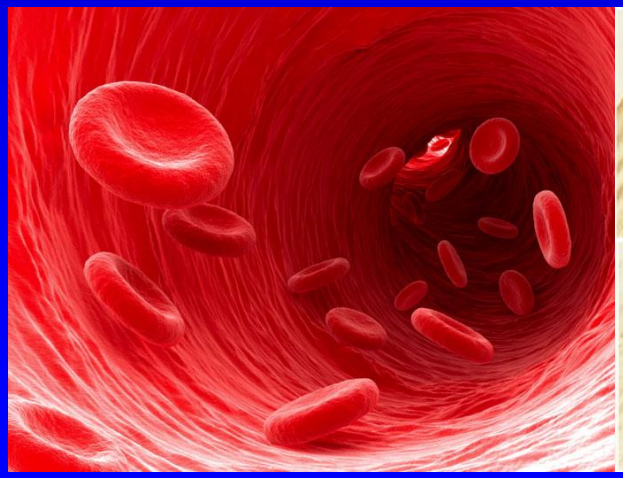
Tissue incorporation?
Aneurysmal dilation?
Vascular wall calcification?

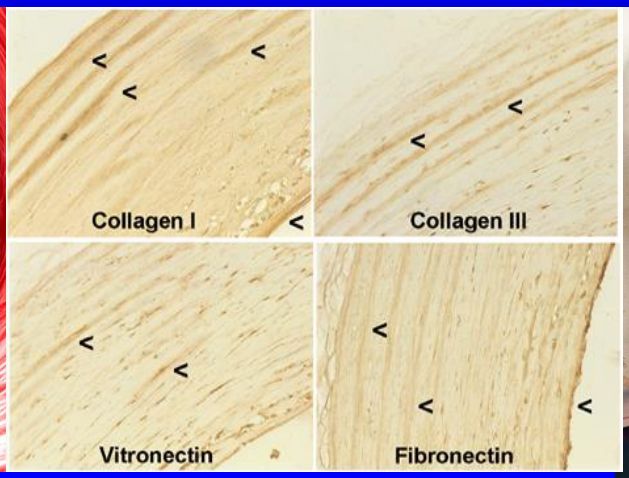


The Tissue Grafts?

Tissue Engineering…..

Making human biomaterials that mimic the function of a human blood vessel.





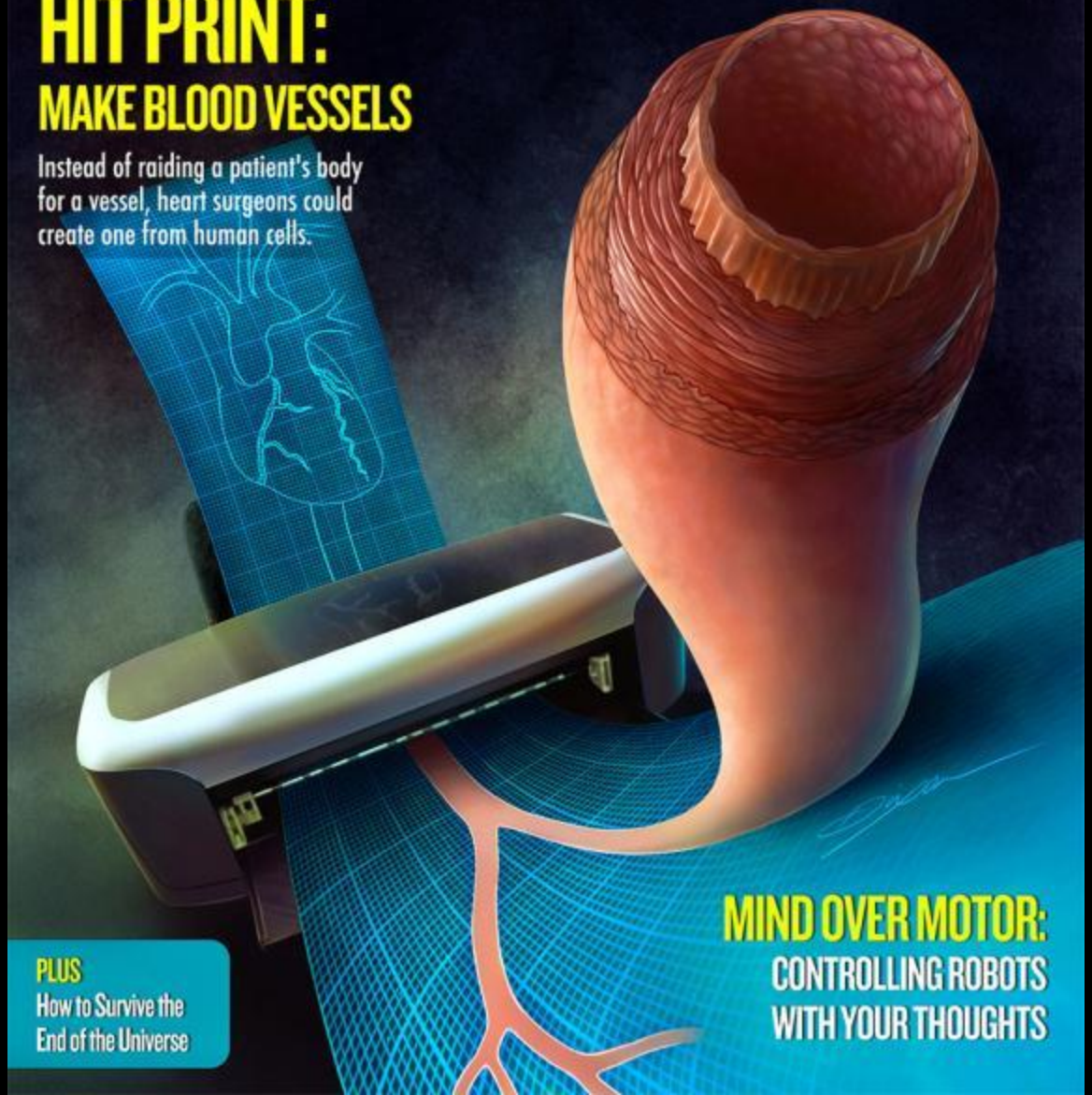


DISCOVER

Science, Technology, and The Future

HIT PRINT:
MAKE BLOOD VESSELS

Instead of raiding a patient's body for a vessel, heart surgeons could create one from human cells.



MIND OVER MOTOR:
CONTROLLING ROBOTS WITH YOUR THOUGHTS

PLUS
How to Survive the End of the Universe

Elastin-based Materials

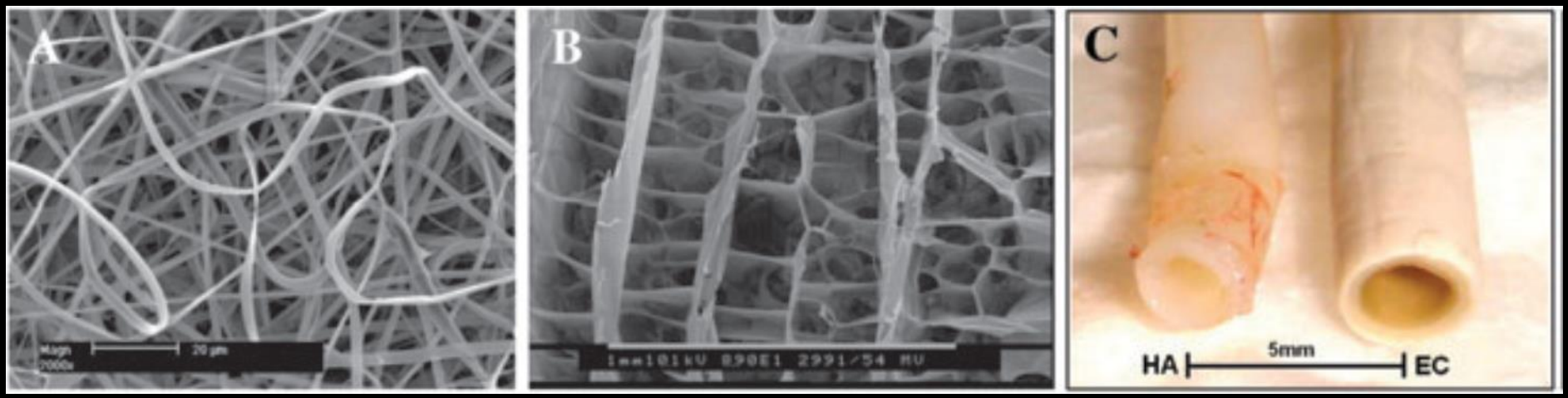
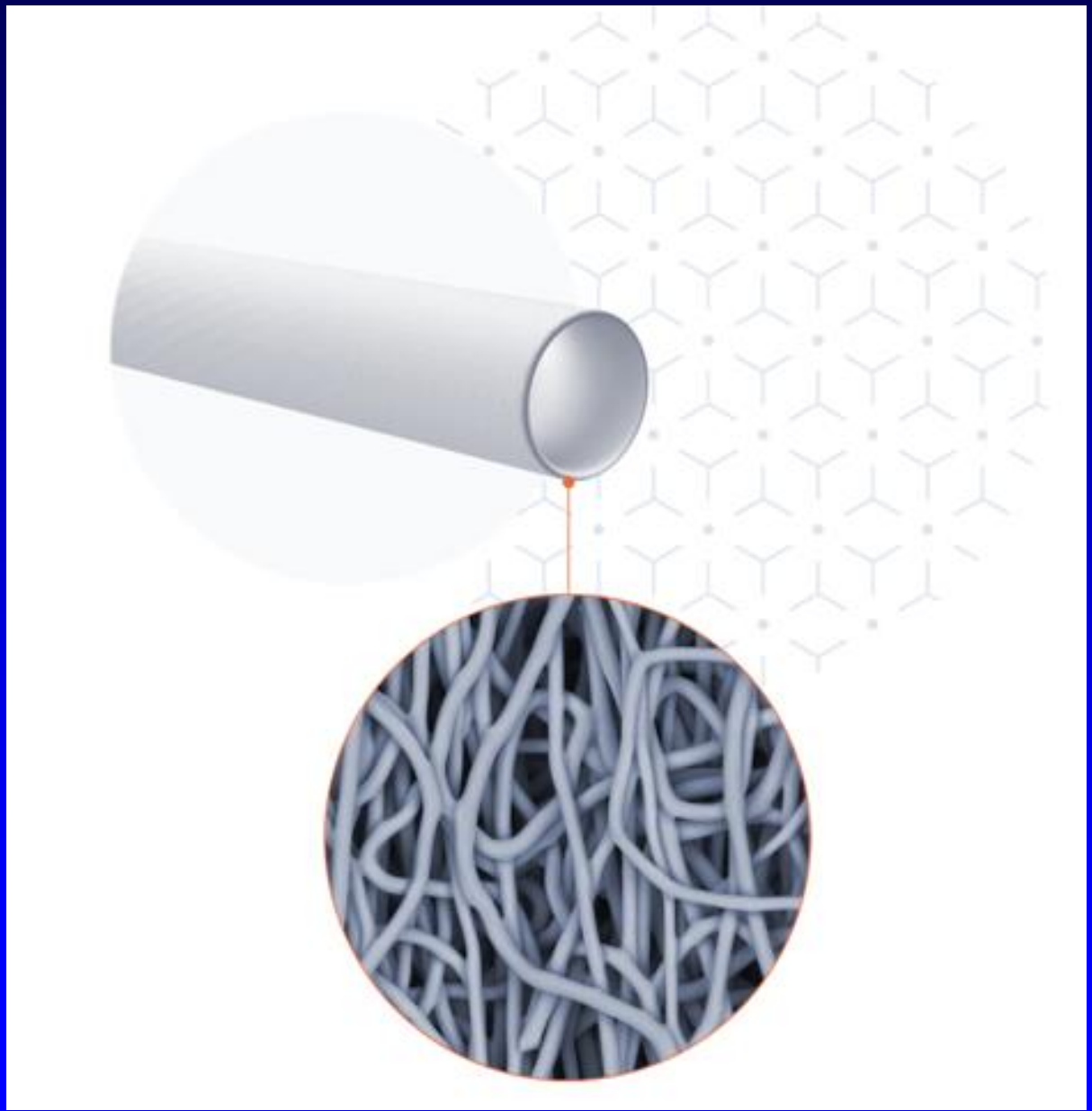


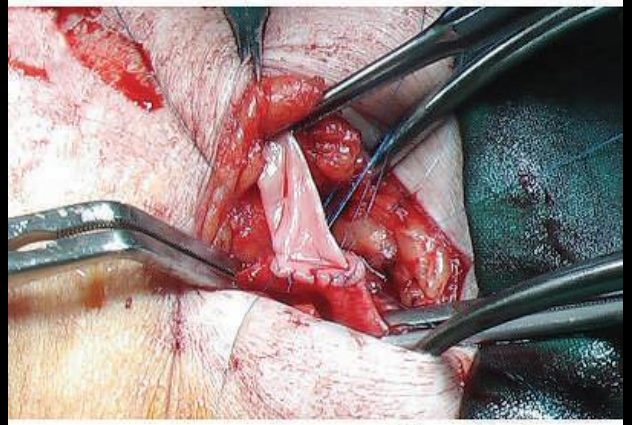
Fig. 1 Synthetic elastin tissue engineered constructs. Scanning electron microscopy images of (A) synthetic elastin electrospun fibers and (B) hydrogel. (C) Digital image of an electrospun conduit (EC) compared to a human artery (HA).

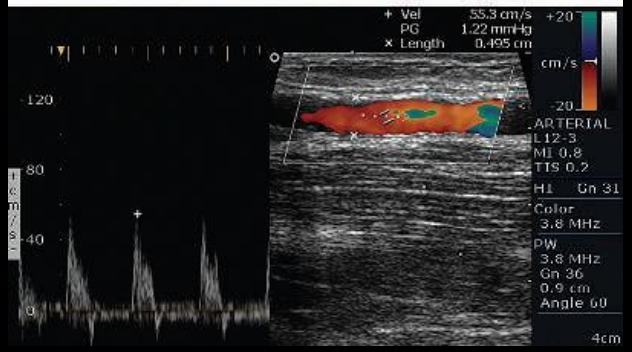
Xeltis – Electrospun Polymer

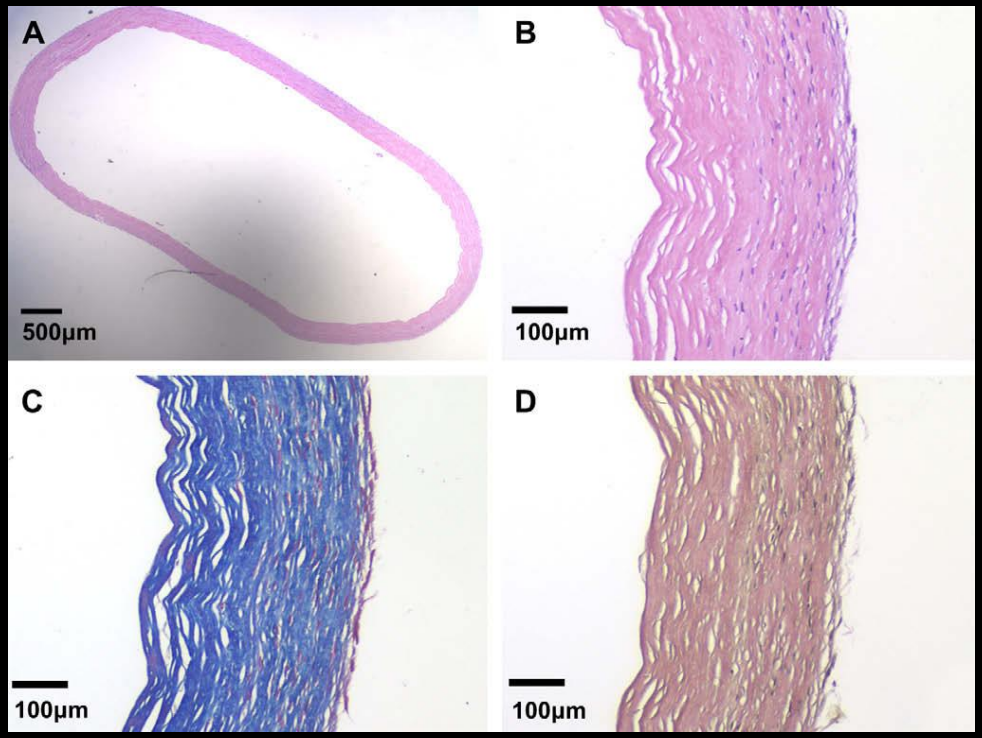


CYTOGRAFT
Tissue Engineering

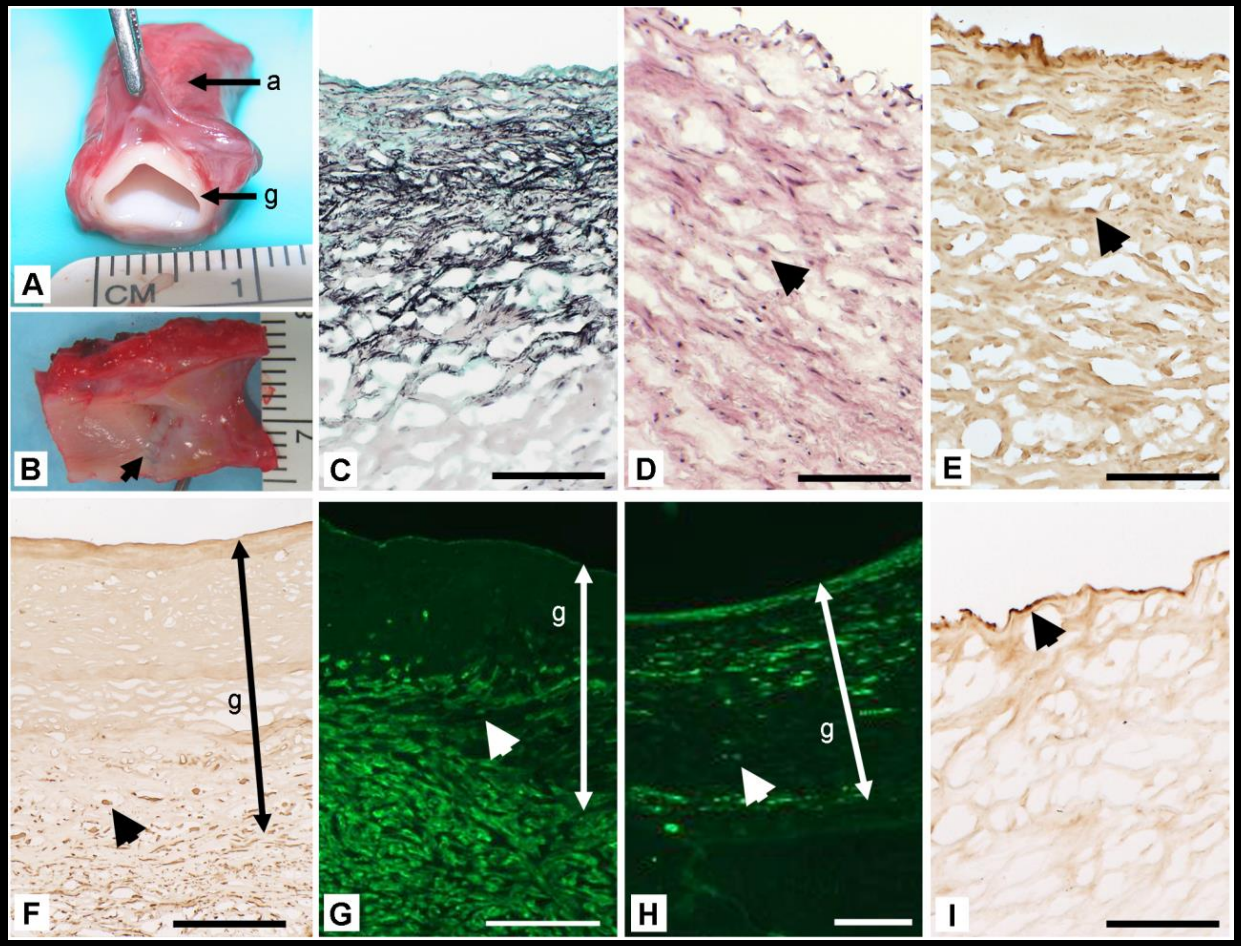








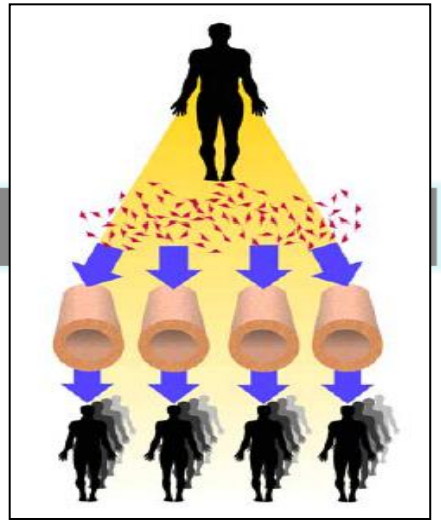
HUMACYTE





Investigational Bioengineered Vessels are Created in the Laboratory

1. Human Cells Isolated and Banked

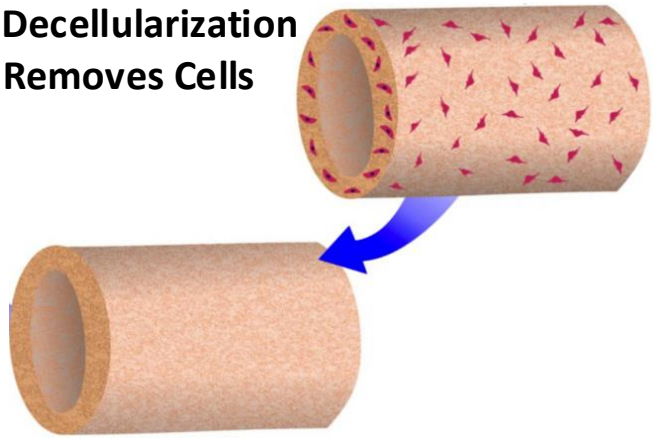


2. Cells are Used to Culture Bioengineered Vessels in Bioreactors





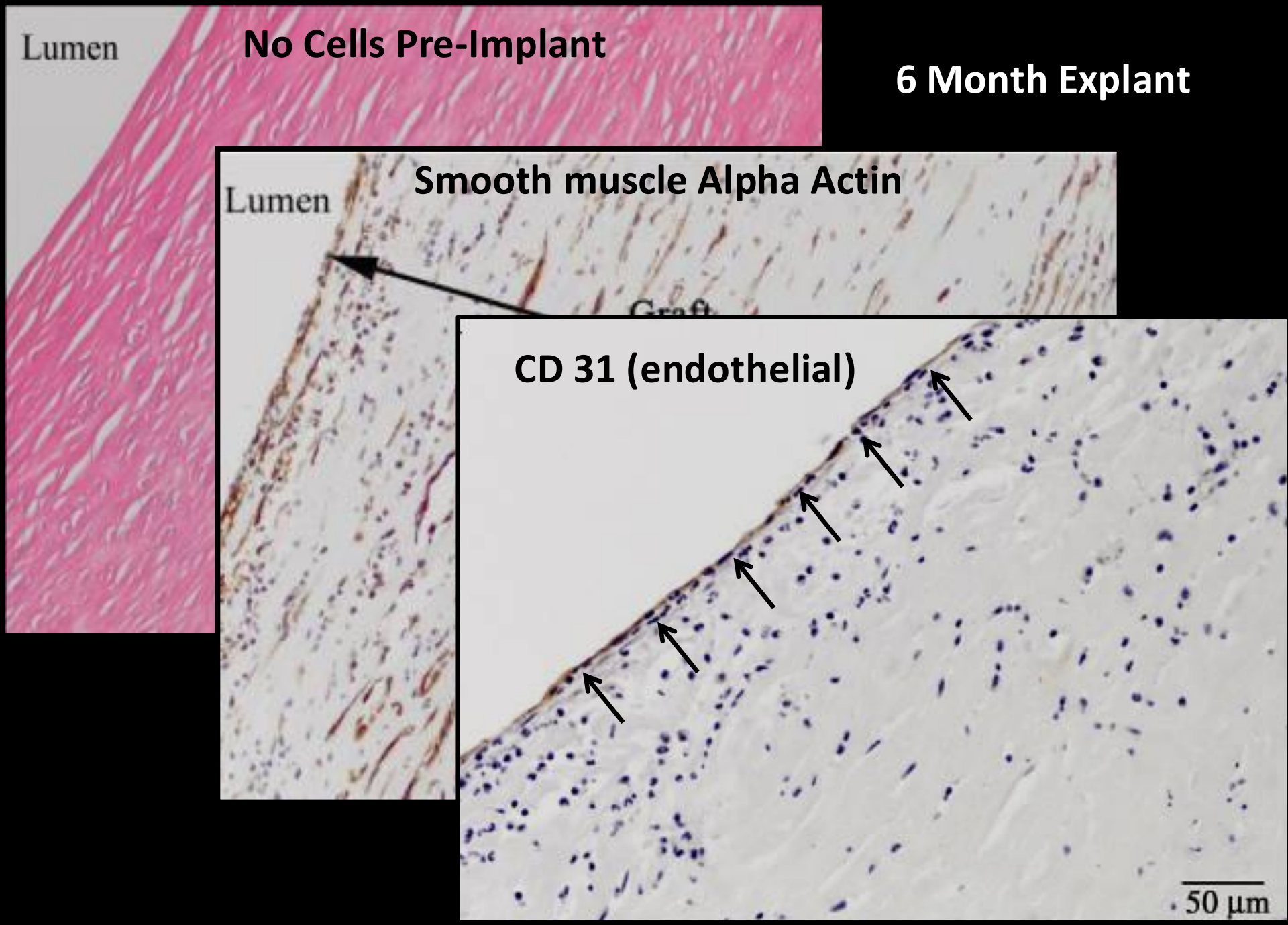
3. Decellularization Removes Cells



4. Bioengineered Vessel Without Branches



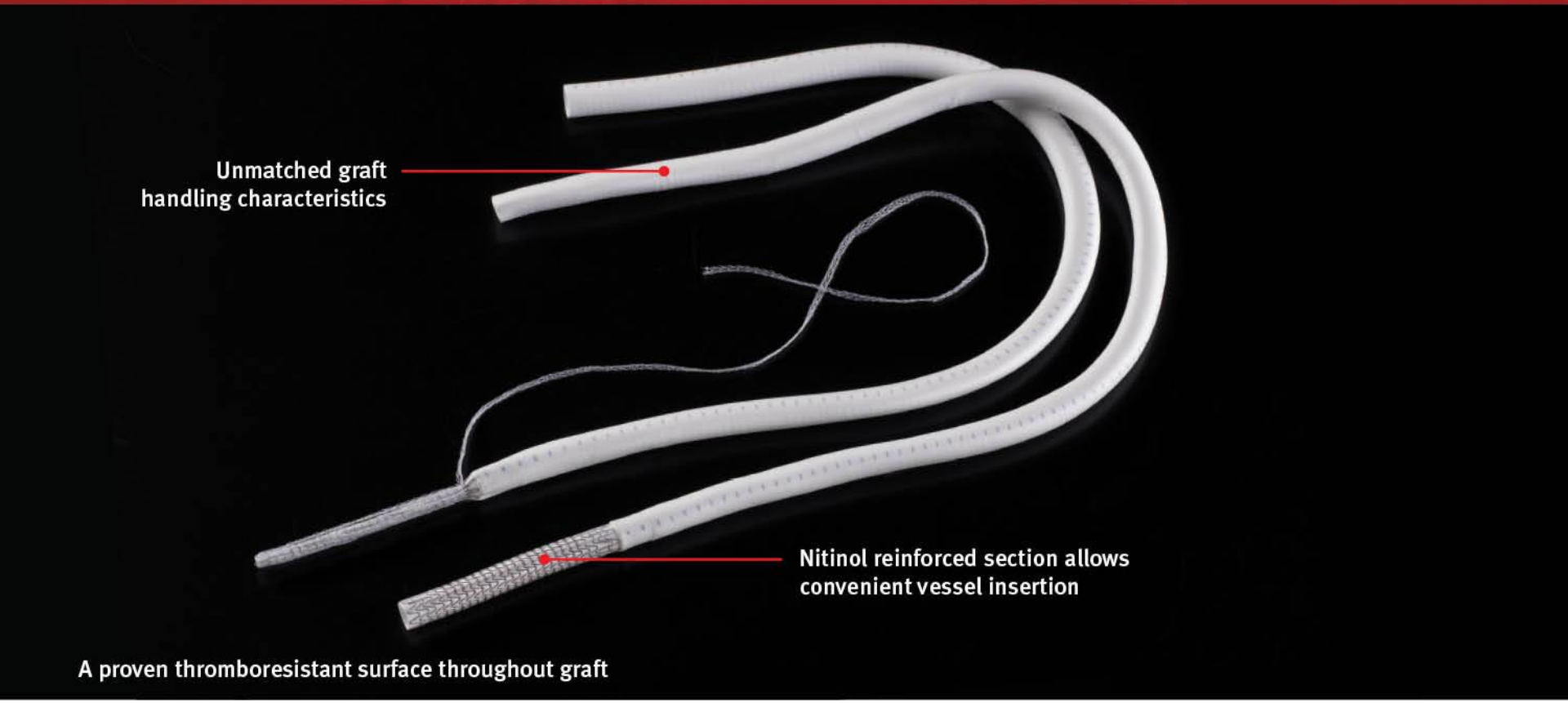
HUMACYTE


Lumen
No Cells Pre-Implant
6 Month Explant
Lumen
Smooth muscle Alpha Actin
Graft
CD 31 (endothelial)
50 µm




CAR

Extended Reach with an Endoluminal Anastomosis

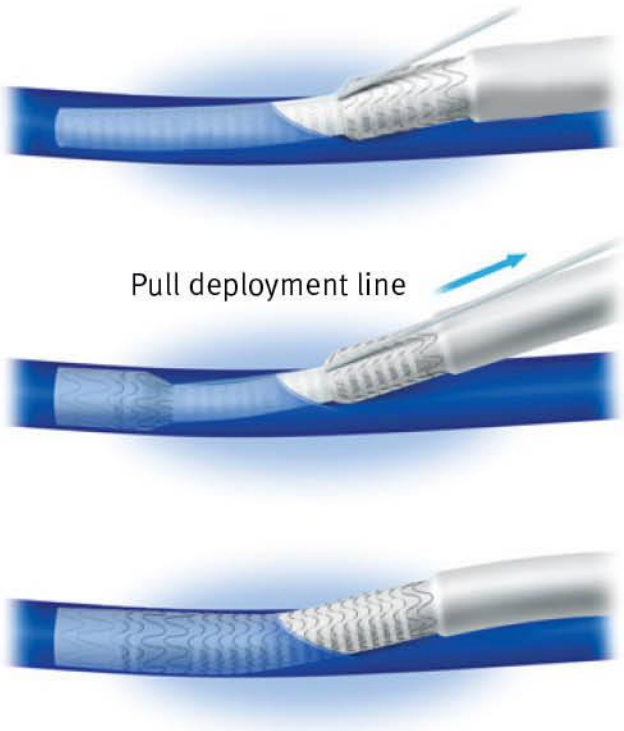


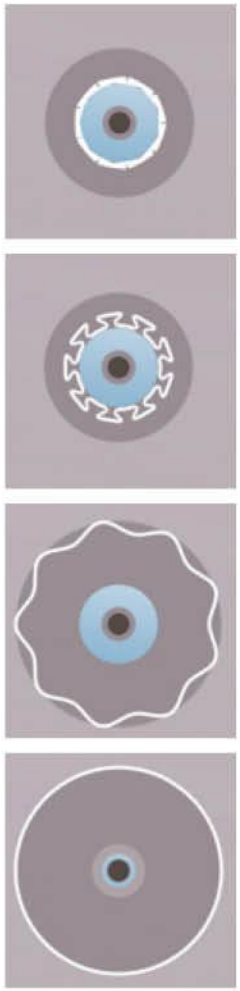
A proven thromboresistant surface throughout graft

GORE HYBRID VASCULAR GRAFT

Stages of Deployment

The nitinol reinforced section should be introduced into the vessel by at least 2.5 cm

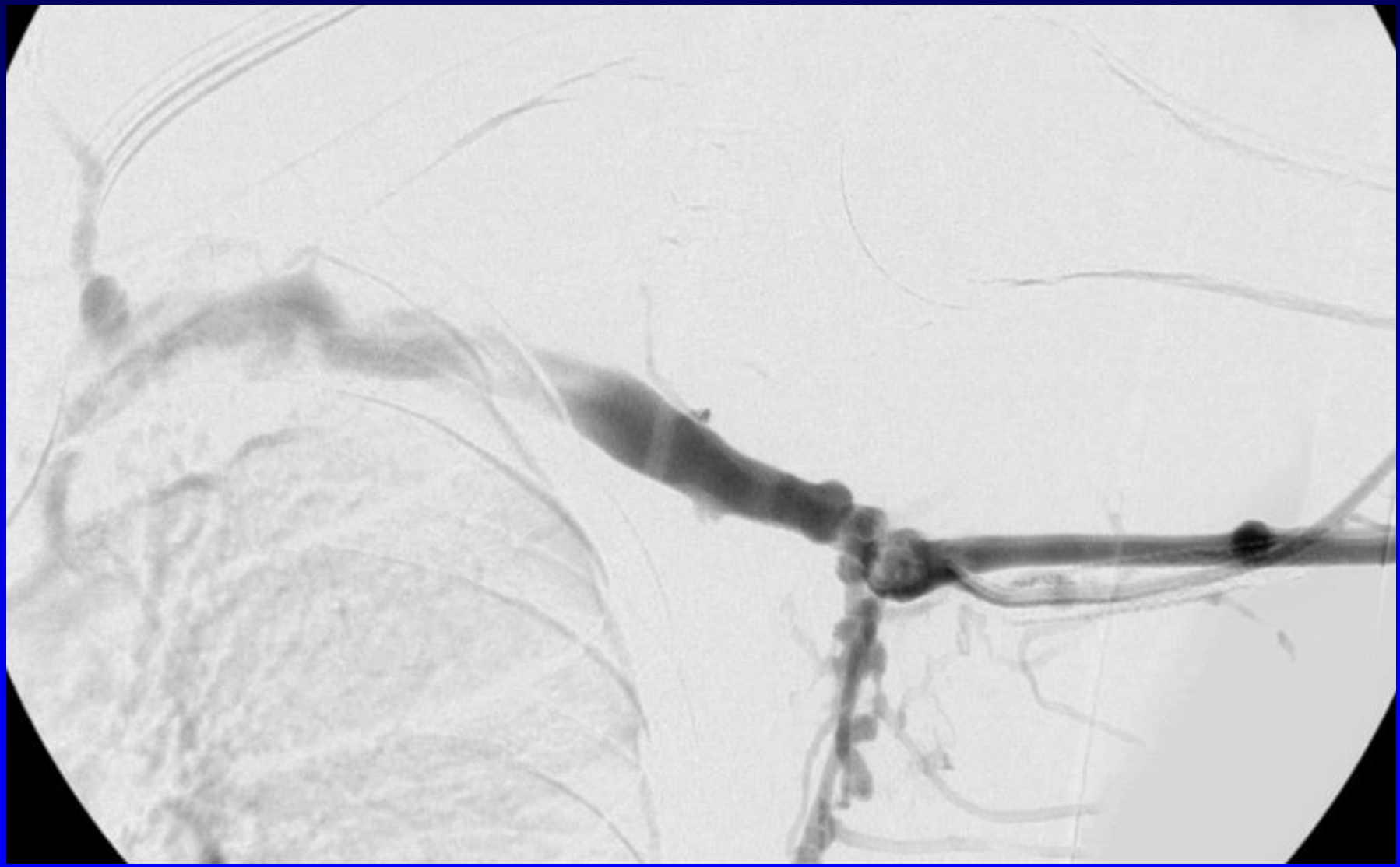




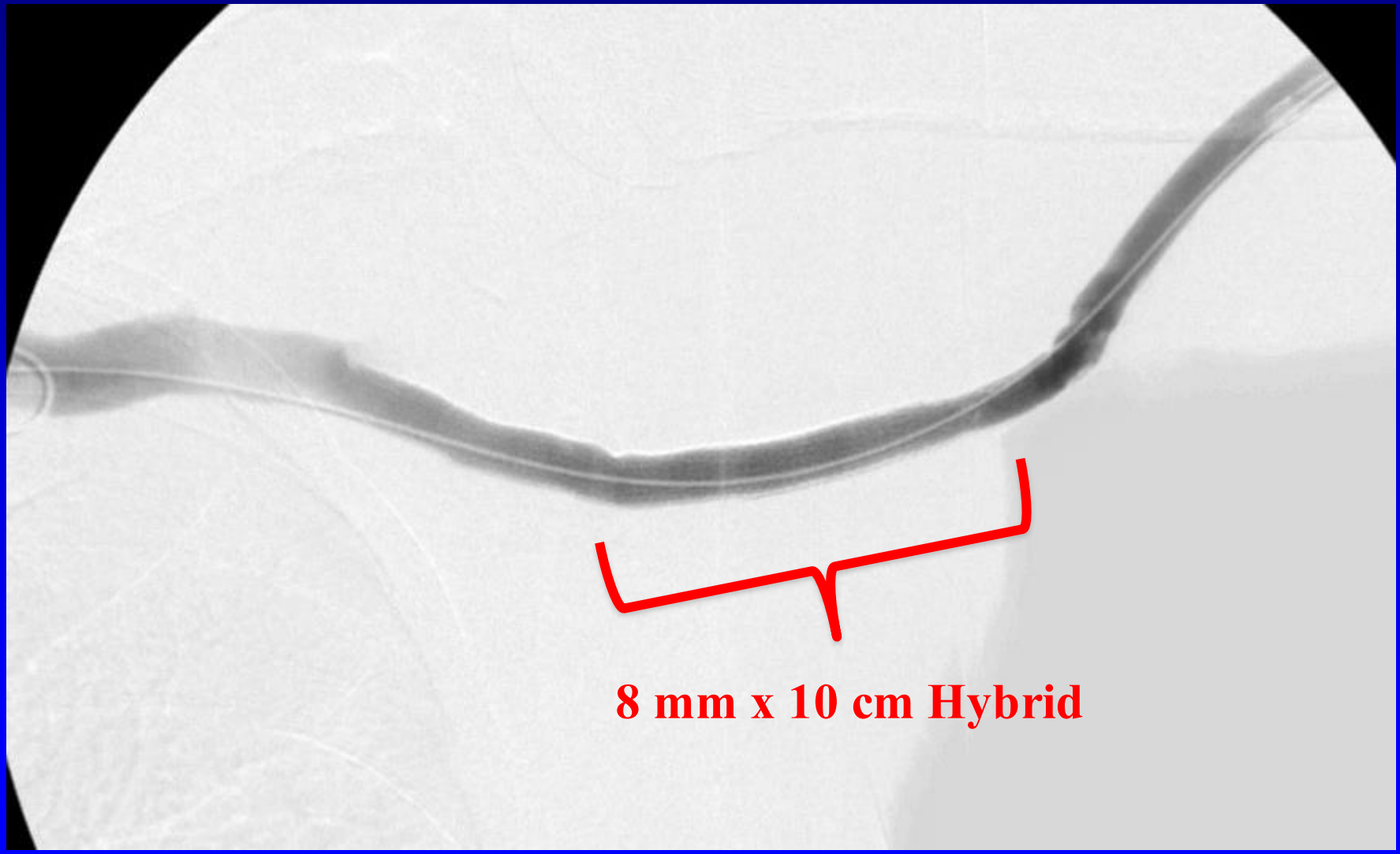
Radial Deployment

GORE HYBRID VASCULAR GRAFT

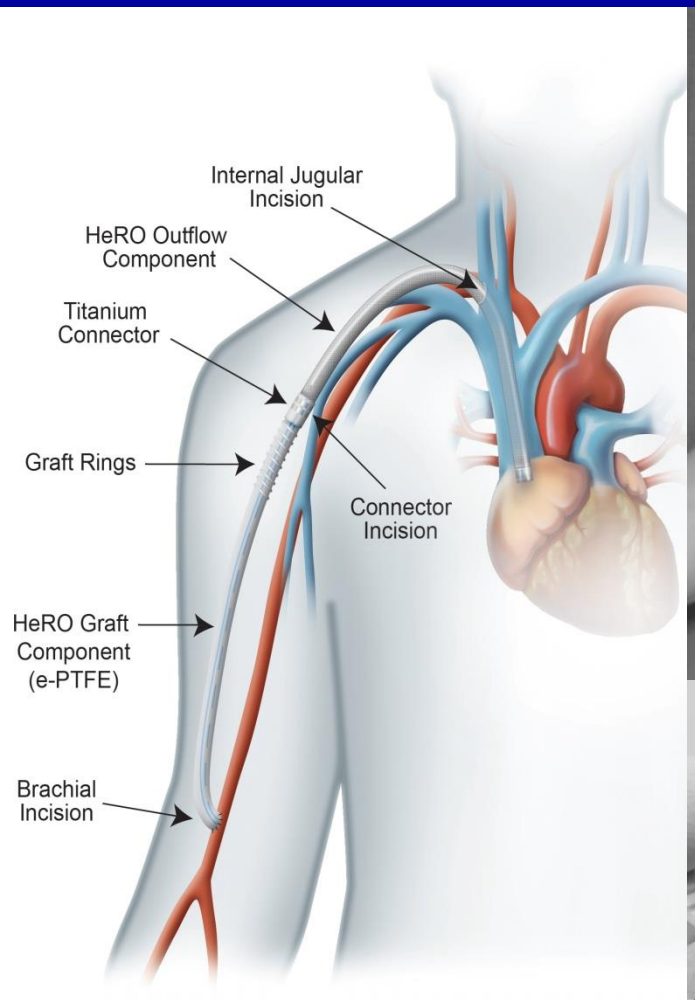
Axillary/Subclavian Vein Pathology

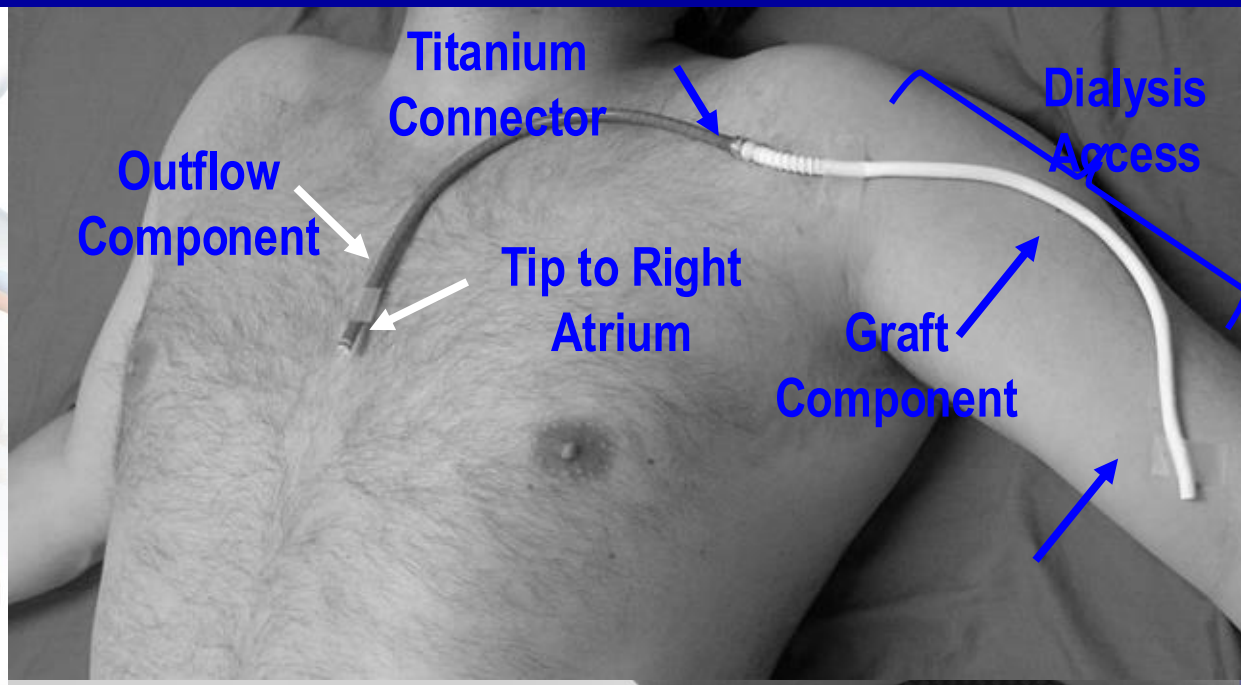


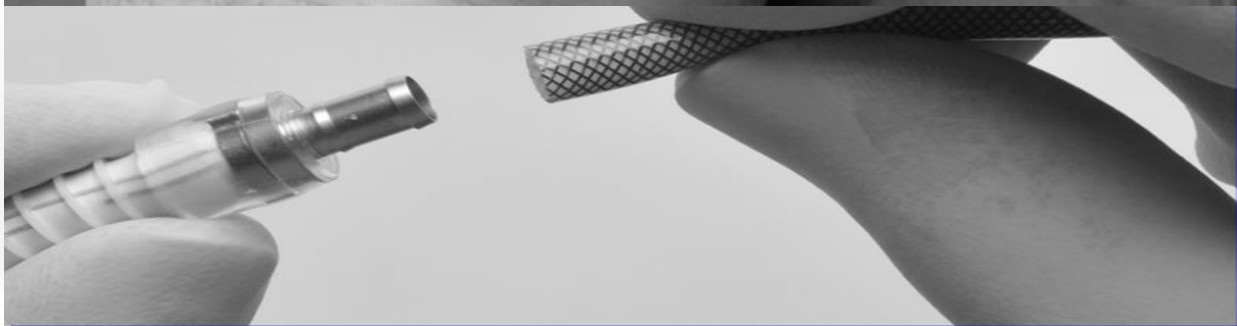
Bypass the Pathology: Hybrid Graft



Hemodialysis with Reliable Outflow (HeRO)







Swollen Arm with working AVF

Hemodialysis Reliable Outflow (HeRO™)



Summary

- Lots of AV Grafts used in the US
- Better than a catheter….but worse than a fistula (in most cases)
- Can be implanted almost anywhere in the body
  - Connect a good artery to a good vein in a stickable place
- Predictable failure and will have to be fixed once a year
- New devices extend access patency in complex patients

Thank You