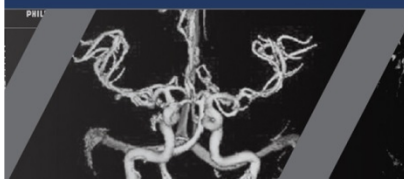
New Tools In Thrombectomy

David Dexter, MD, FACS
Assistant Professor of Surgery EVMS
Sentara Vascular Specialists



Disclosures

- Research Trials
  - Inari
  - Penumbra
  - Angiodynamics
  - Boston Scientific
  - EKOS
- Consultant
  - Penumbra
  - Angiodynamics
  - Boston Scientific

Categories in Thrombectomy

- Thrombolysis
- Pharmaco-mechanical Thrombectomy
- Mechanical Thrombectomy

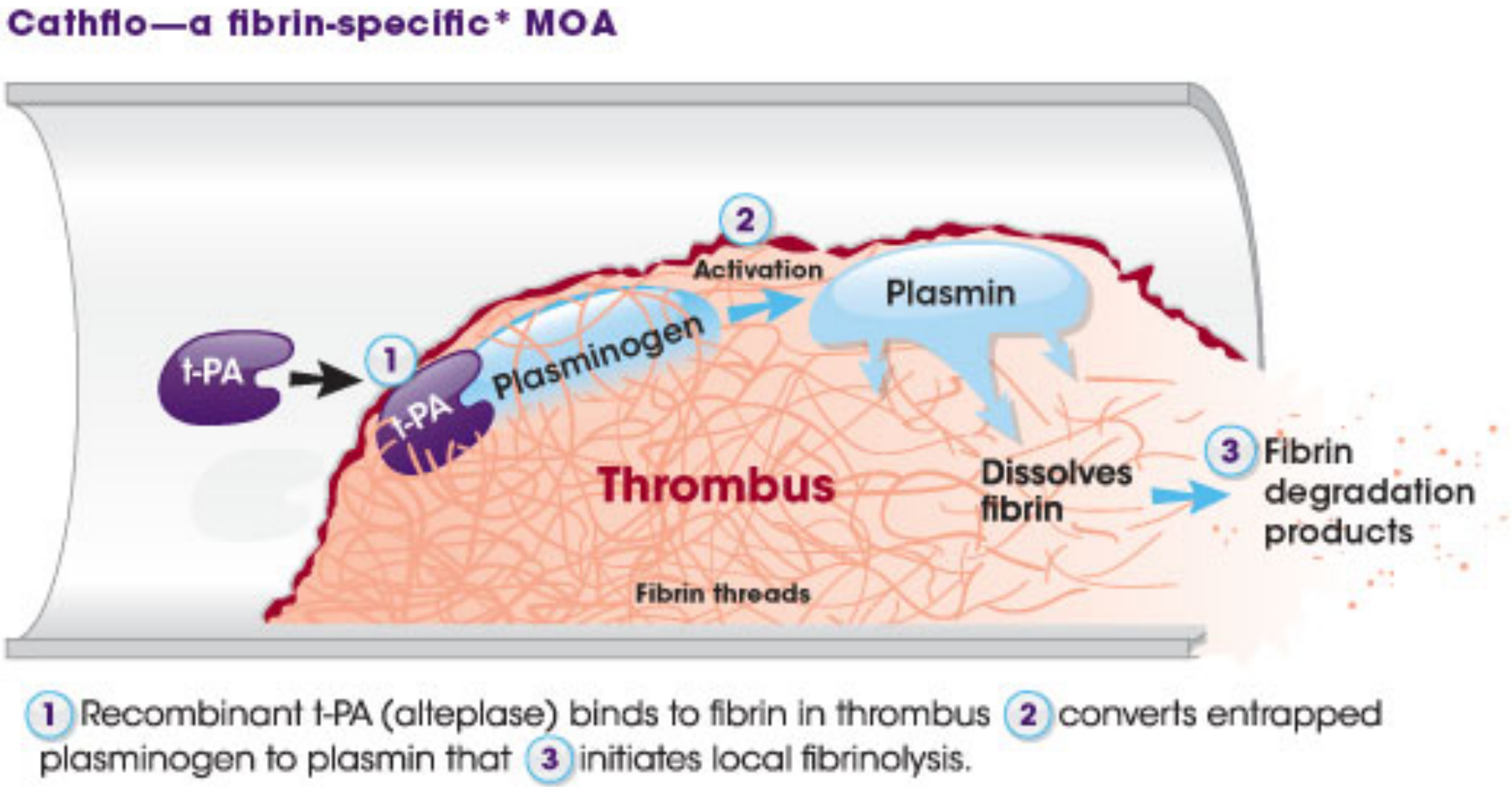
Pharmacologic Thrombolysis

- Placement of a catheter into a thrombosed vessel and the delivery of TPA directly to the thrombus
- Advantages
  - Small Catheter sizes
  - Can do in most sized vessels
  - Have access to the vessel for adjunct procedures
- Disadvantages
  - Bleeding Risk
  - Cost of TPA

Drugs Required for Clot Removal

- Pharmacologic
  - Thrombolytics
    - Tissue Plasminogen Activator TPA
    - Urokinase and Streptokinase (Historic)
  - Anticoagulants IV, Injectable and Oral
    - Heparin
    - Direct Thrombin Inhibitors
    - VKA
    - Xa
  - Antiplatelets
    - IIB/IIIA Inhibitors (Aggrostat, Integrelin and Reopro)
    - ASA
    - Effient, Brilinta, Plavix

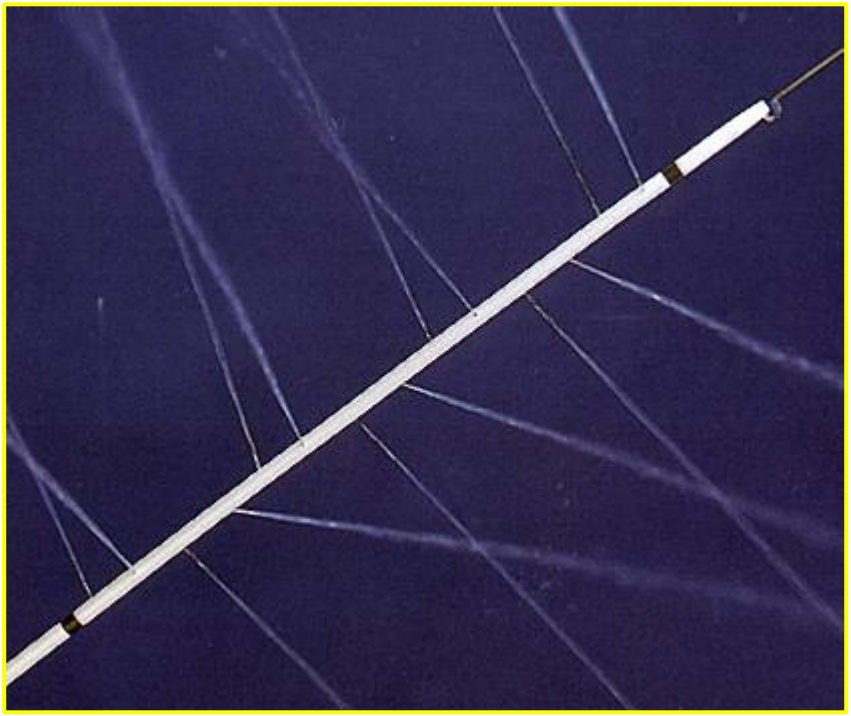
Mechanism of TPA

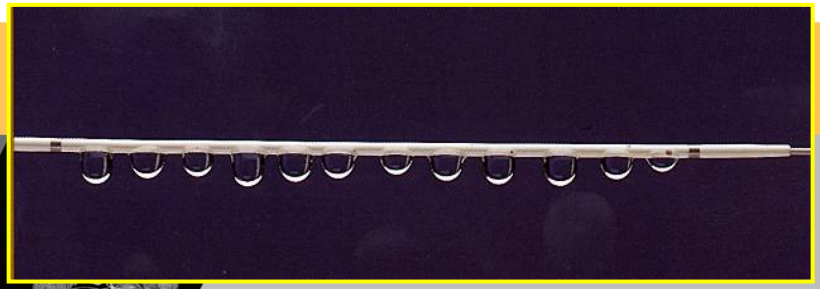


Francis, Charles W. et al. "Ultrasound Accelerates Transport of Recombinant Tissue Plasminogen Activator into Clots." Ultrasound in Medicine and Biology 21.3 (1995):419-424.

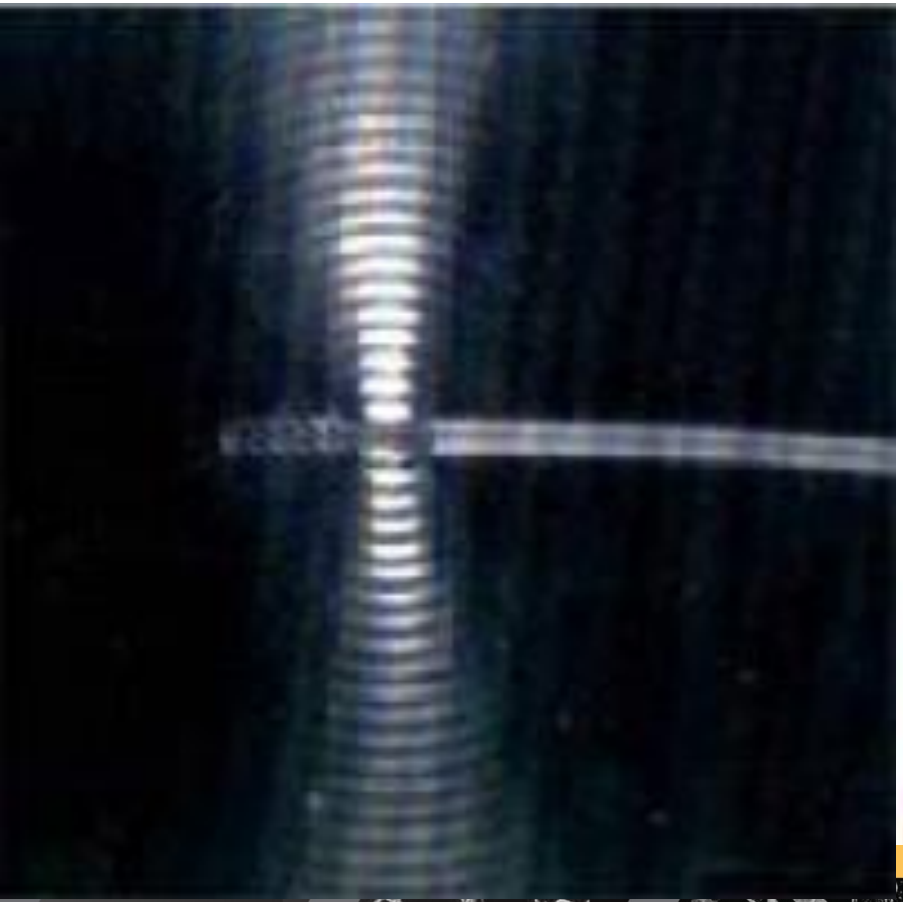
Infusion Soaker Catheters

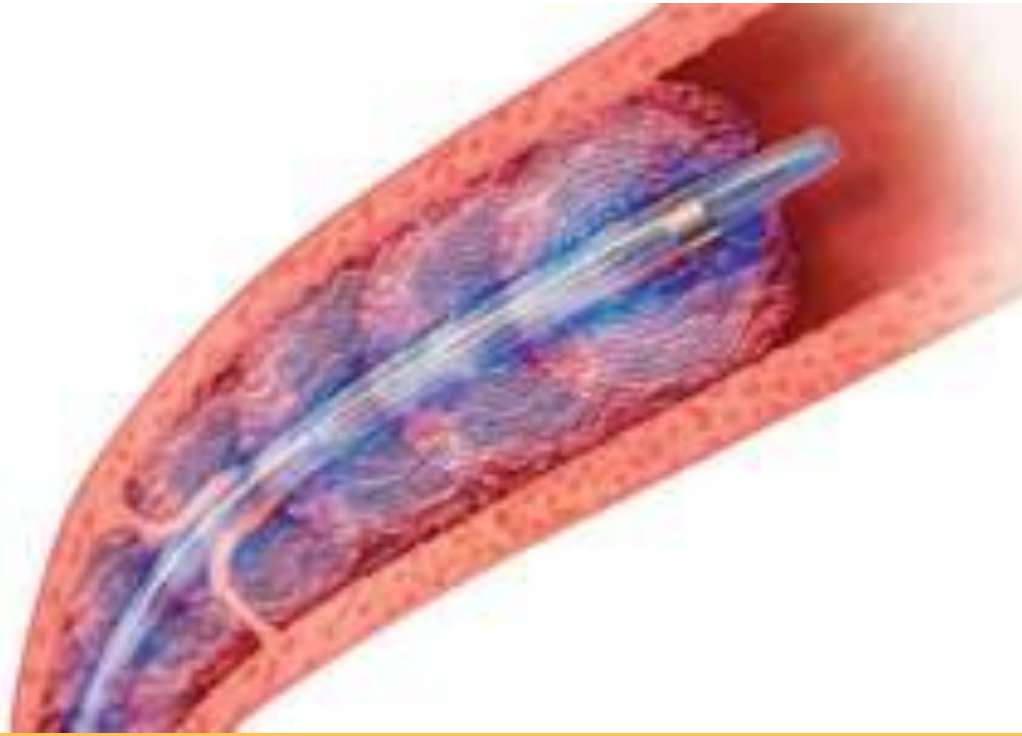
- **Varying lengths of Soaker Holes**
- **Need Wire Occlusion (0.35”) through tip**





EKOS





EKOS Catheter

1. Transport the drug TO the clot

   (Infusion Catheter)

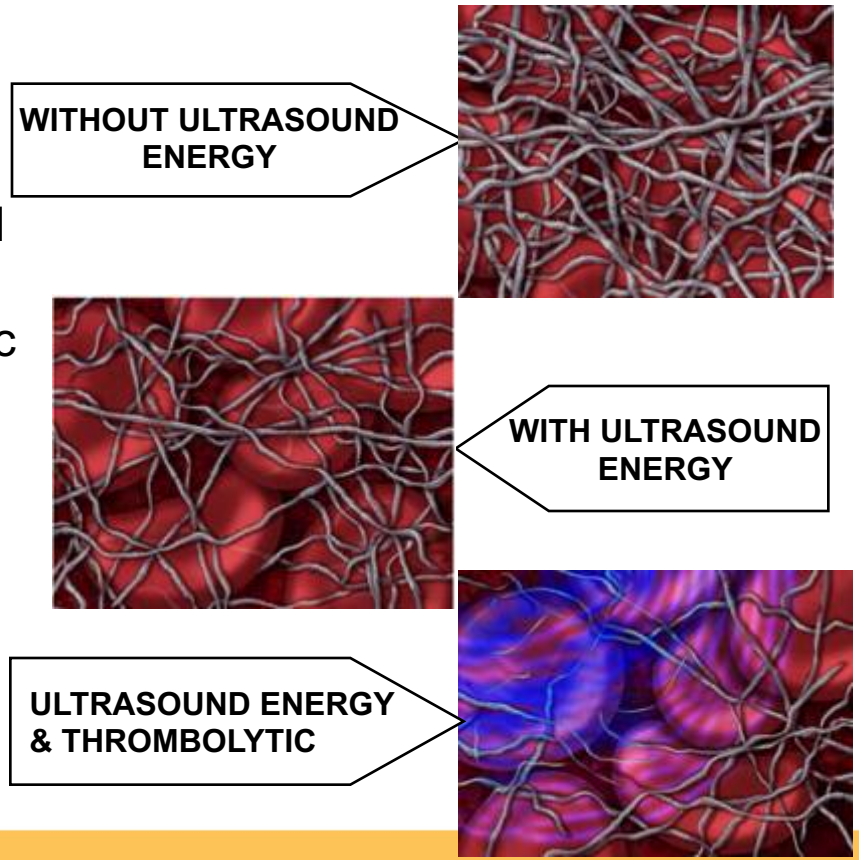
2. Transport the drug INTO the clot

   (Ultrasound Core)

EKOS Mechanism

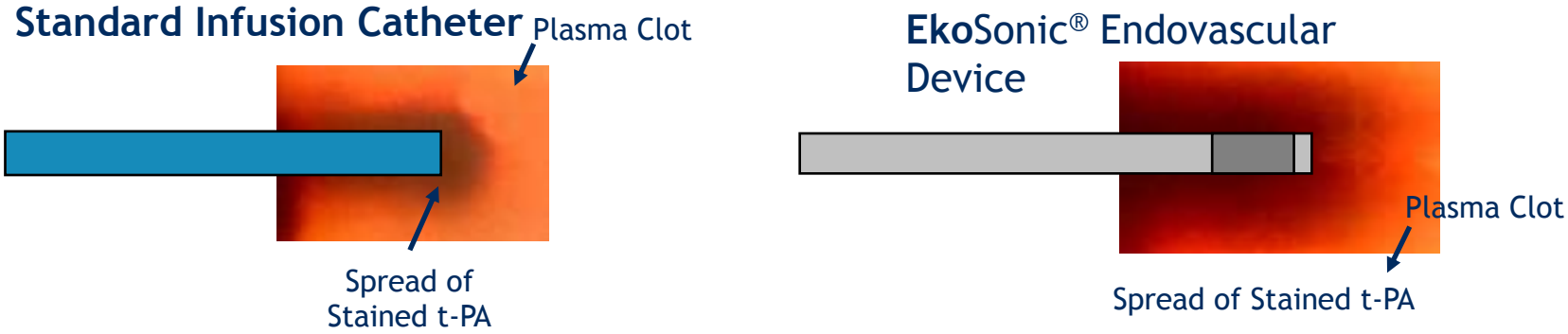
Mechanism of Action

- Ultrasonic energy causes fibrin strands to thin, exposing plasminogen receptor sites and fibrin strands to loosen
- Thrombus permeability and lytic penetration are dramatically increased
- Ultrasound pressure waves force lytic agent deep into the clot and keep it there

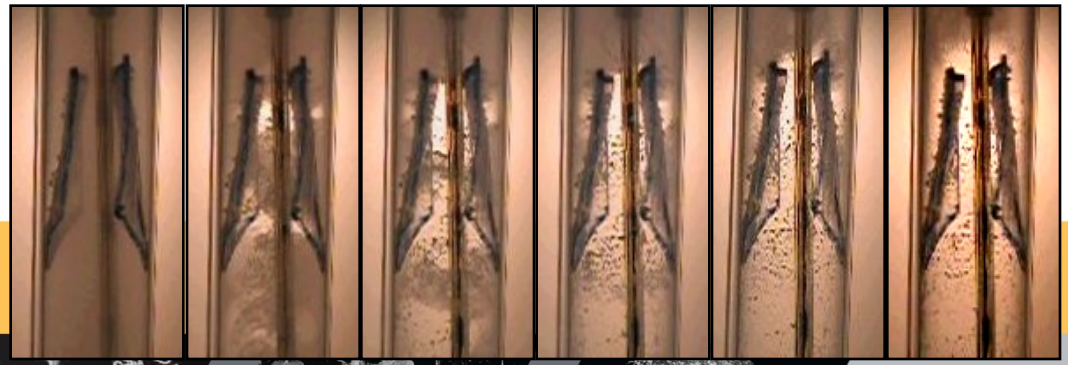


Braaten et al. Thromb Haemost 1997; 78:1063

EKOS Mechanism



Thrombus exposed to ultrasound *absorbed 48% more t-PA in one hour, 84% more t-PA in two hours and 89% more t-PA in 4 hours* than thrombus not exposed to microsonic pressure.[3]

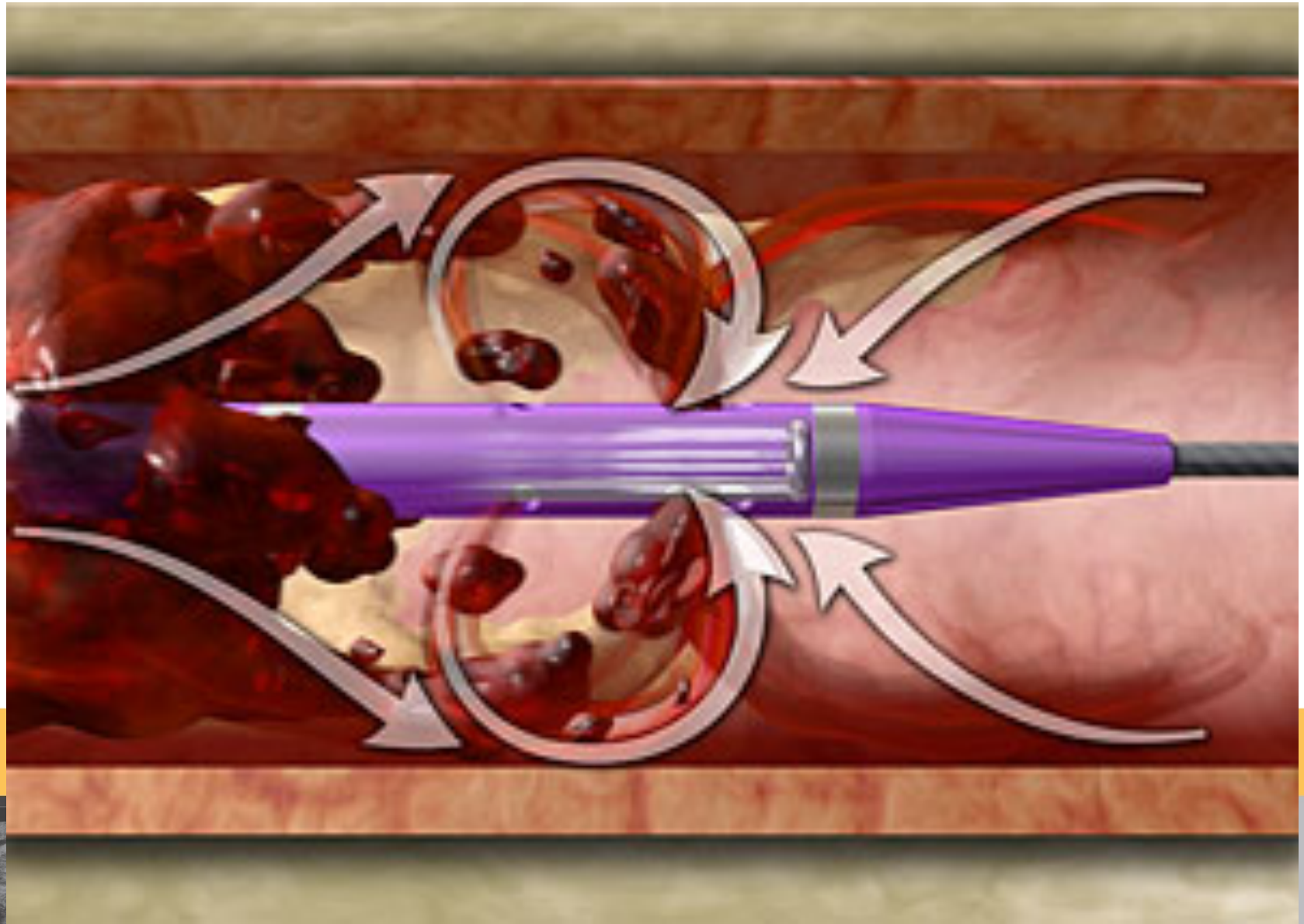


[3]Francis, CW, et al. "Ultrasound Accelerates Transport of Recombinant Tissue Plasminogen Activator into Clots." Ultrasound in Medicine and Biology 21.3 (1995): 419-424.

Pharmacomechanical Thrombectomy

- Advantages
  - Single Stage procedure
  - May decrease total time of indwelling catheters
  - Rapid resolution of symptoms.
  - Reduce or eliminate the exposure to thrombolytics and/or anticoagulants.
  - Provides access for other venous adjuvant surgery
- Disadvantages
  - Severe Arrhythmias
  - Potential for hemolysis and ATN/Shock Kidney
  - Potential hemolytic induced pancreatitis

Angiojet



Angiojet

- Over the Wire system.
- Indicated in arterial and venous system

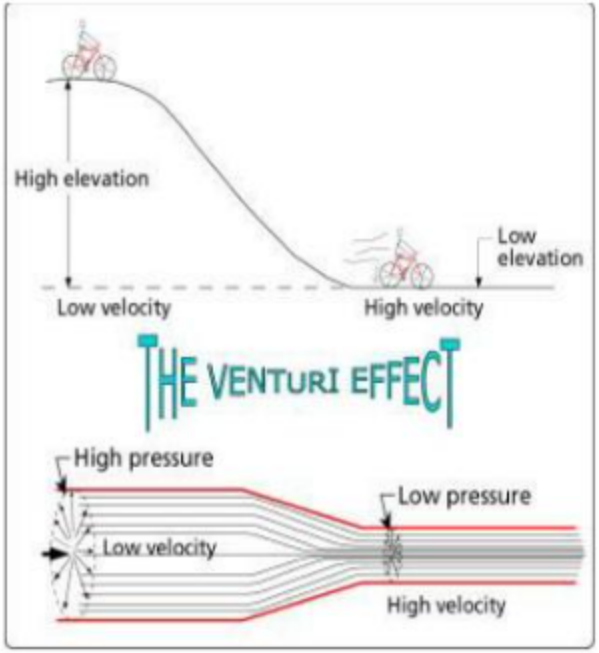
- Delivery of thrombolytic drug through a power pulse mode

- Rheolytic removal of drug using thrombectomy mode

Angiojet

The Venturi Effect

- It is a special case of Bernoulli's Principle
- It is a reduction in the pressure of a fluid resulting from the speed increase as fluids are forced to flow faster through narrow spaces

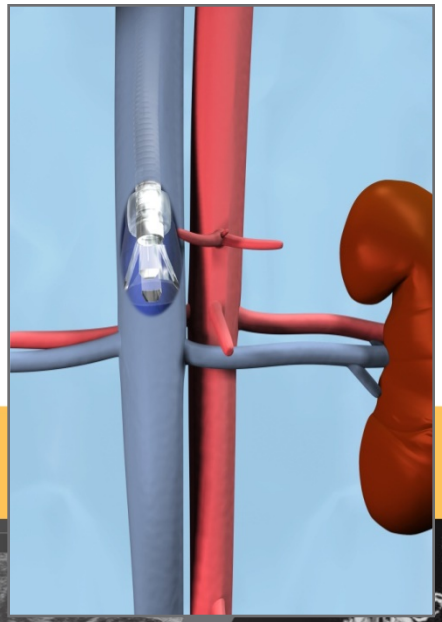


Mechanical Thrombectomy

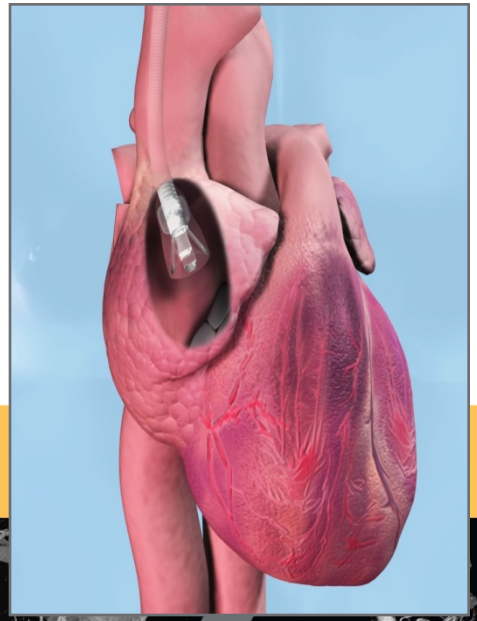
- Extraction of Thrombus without the use of thrombolytic agents
- Advantages
  - Remove thrombi and emboli in one setting and treat the underlying stenosis
  - Able to treat large and small vessel sizes
  - Reduce the need for thrombolytic therapy
  - Still have other treatment options open, if needed
- Disadvantages
  - Catheters that pass into small vessels can be traumatic
  - Ineffective force to remove subacute thrombus

AngioVac

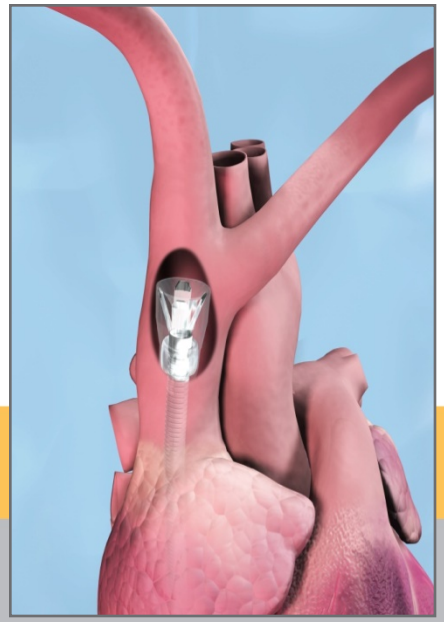
- The AngioVac Cannula is indicated for use as a venous drainage cannula and for removal of fresh, soft thrombi or emboli during



Inferior Vena Cava



Right Atrium

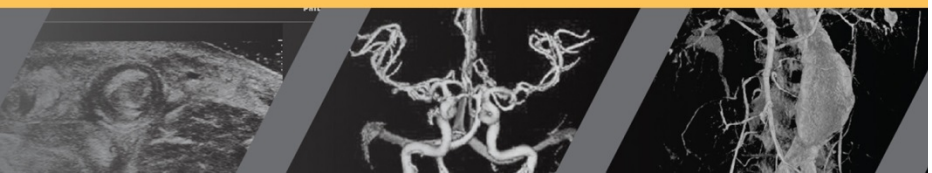


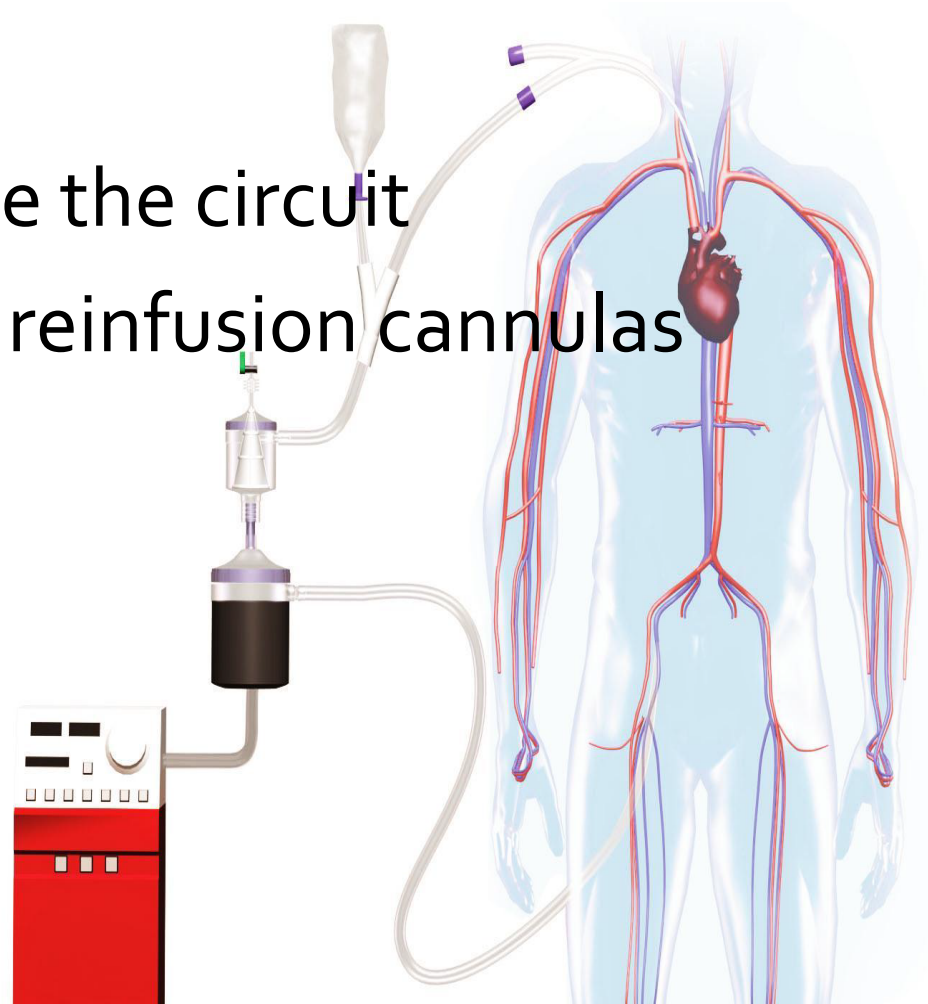
Superior Vena Cava

AngioVac

Procedure Description

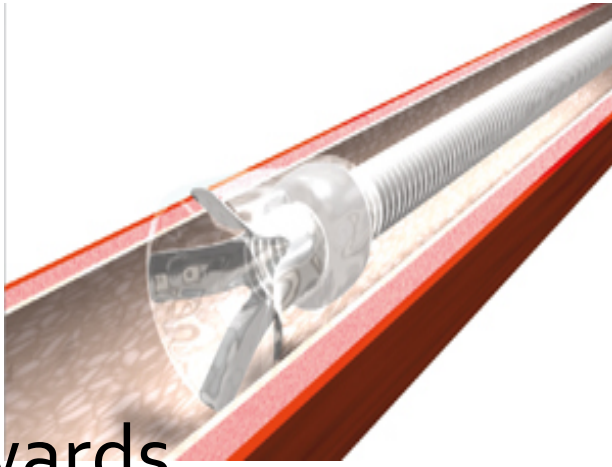
- 26 Fr AngioVac Cannula
- 18 Fr Return Cannula
- Flush all tubing and prime the circuit
- Connect the suction and reinfusion cannulas to the circuit



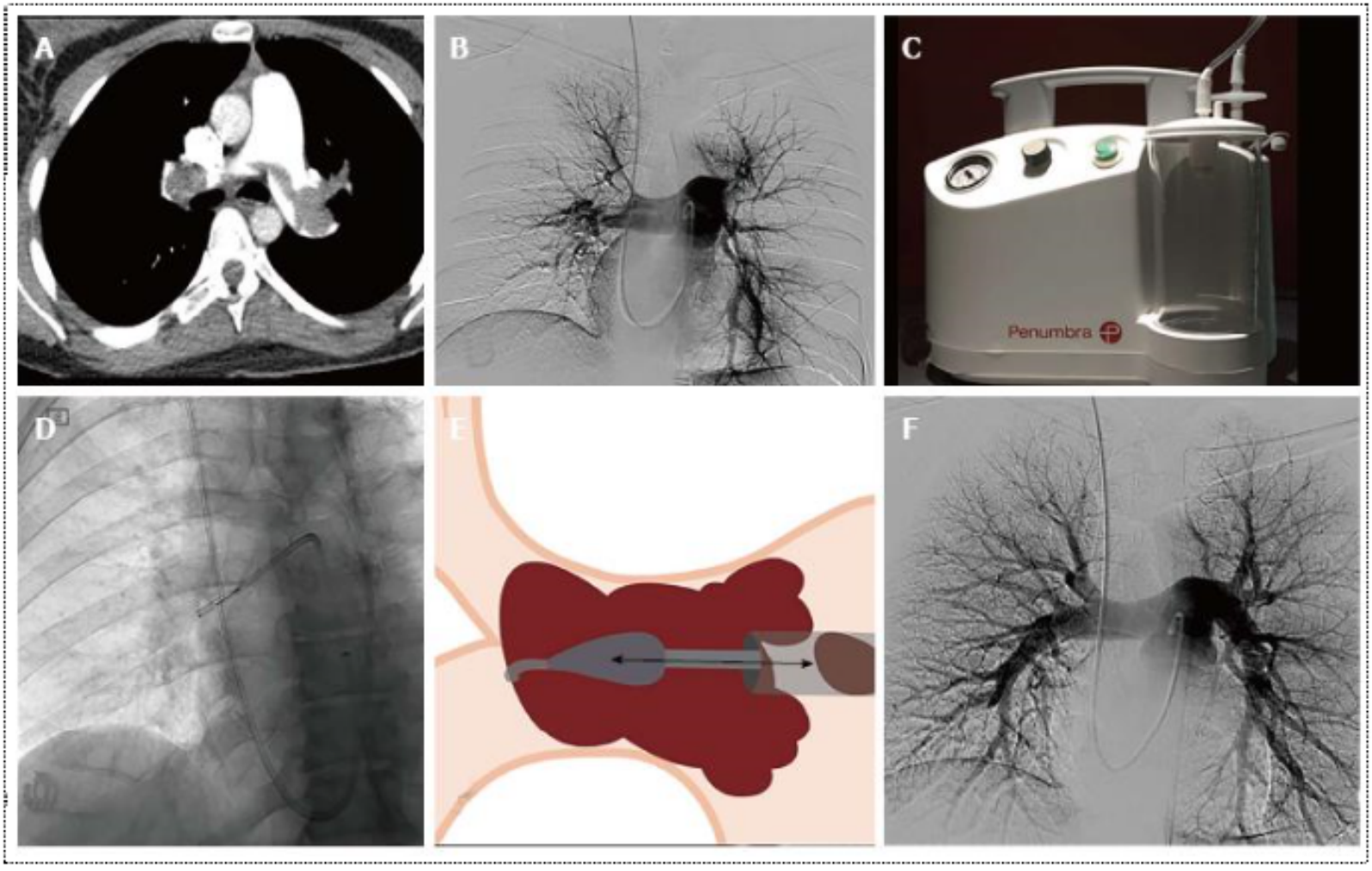


Procedure Description

- Inflate the angiovac balloon
- Start the centrifugal pump
  - Volume flow of 2500-3000 cc/minute
- Advance the angiovac cannula towards the thrombus
- Utilize other techniques to embolize the thrombus into the suction cannula



Penumbra



Penumbra

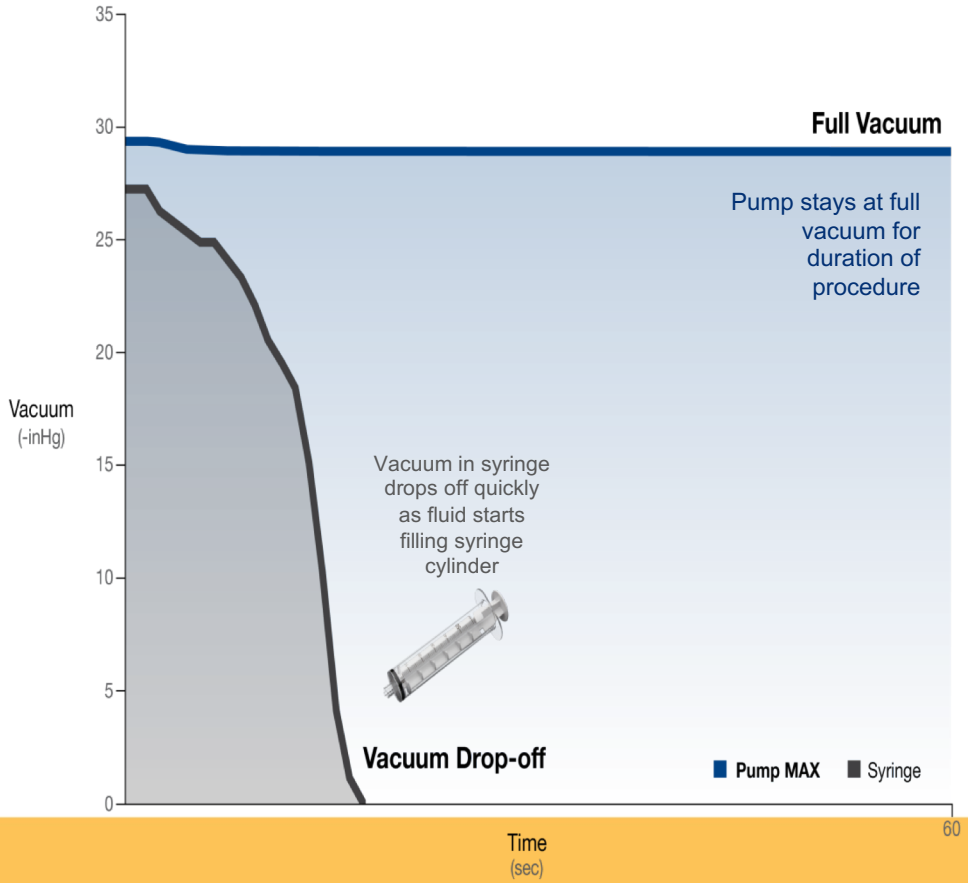
- Mechanical device
- 8Fr
- Able to pull thrombus and blood into a canister
- Atraumatic catheter
- Wire used to assist in morcellation
- Unable to return blood to patient

Indigo System Innovation of Catheters

	CAT 3	CAT 5	CAT 6	CAT 8	CAT D
					
Compatibility (Sheath/Guide)	**4.1 F** Compatibilit v	**6 F** Compatibilit v	**6 F** Compatibilit v	**8 F** Compatibilit v	**8 F** Compatibilit v
Working Length	**150 cm** Length	**132 cm** Length	**135 cm** Length	**85 & 115 cm** Length	**50 cm** Length
Wire Platform	Wire Platform **.014–.025"**	Wire Platform **.014–.038"**	Wire Platform **.014–.038"**	Wire Platform **.014–.038"**	Wire Platform **.014–.038"**
Compatible Penumbra Devices	Separator™ **3**	Separator **5**	Separator **6**	Separator **8**	Separator **D**

Tip Shapes
Straight *(85 cm)*
Torq *(85 cm)*
cm)

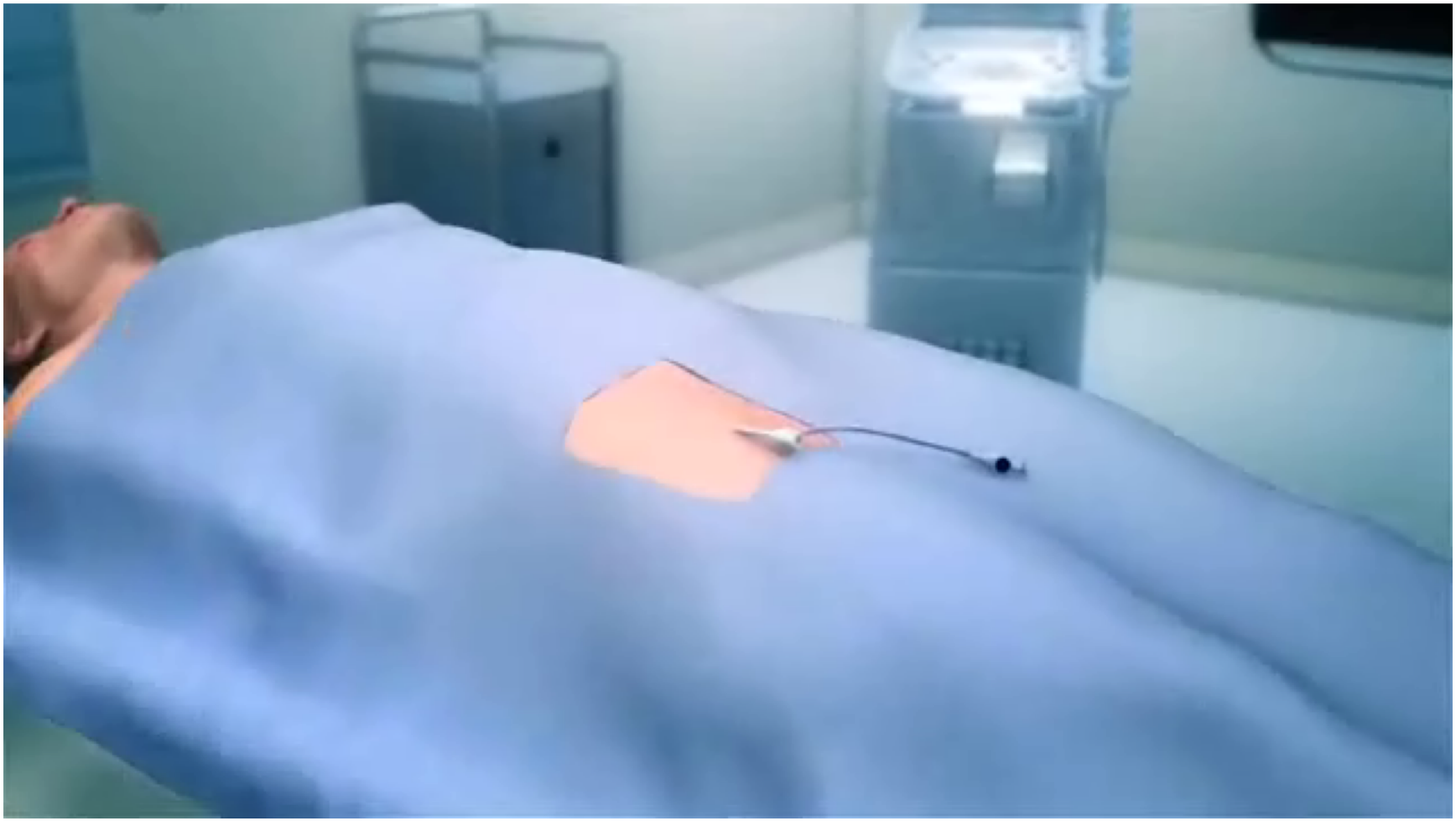
Power Aspiration



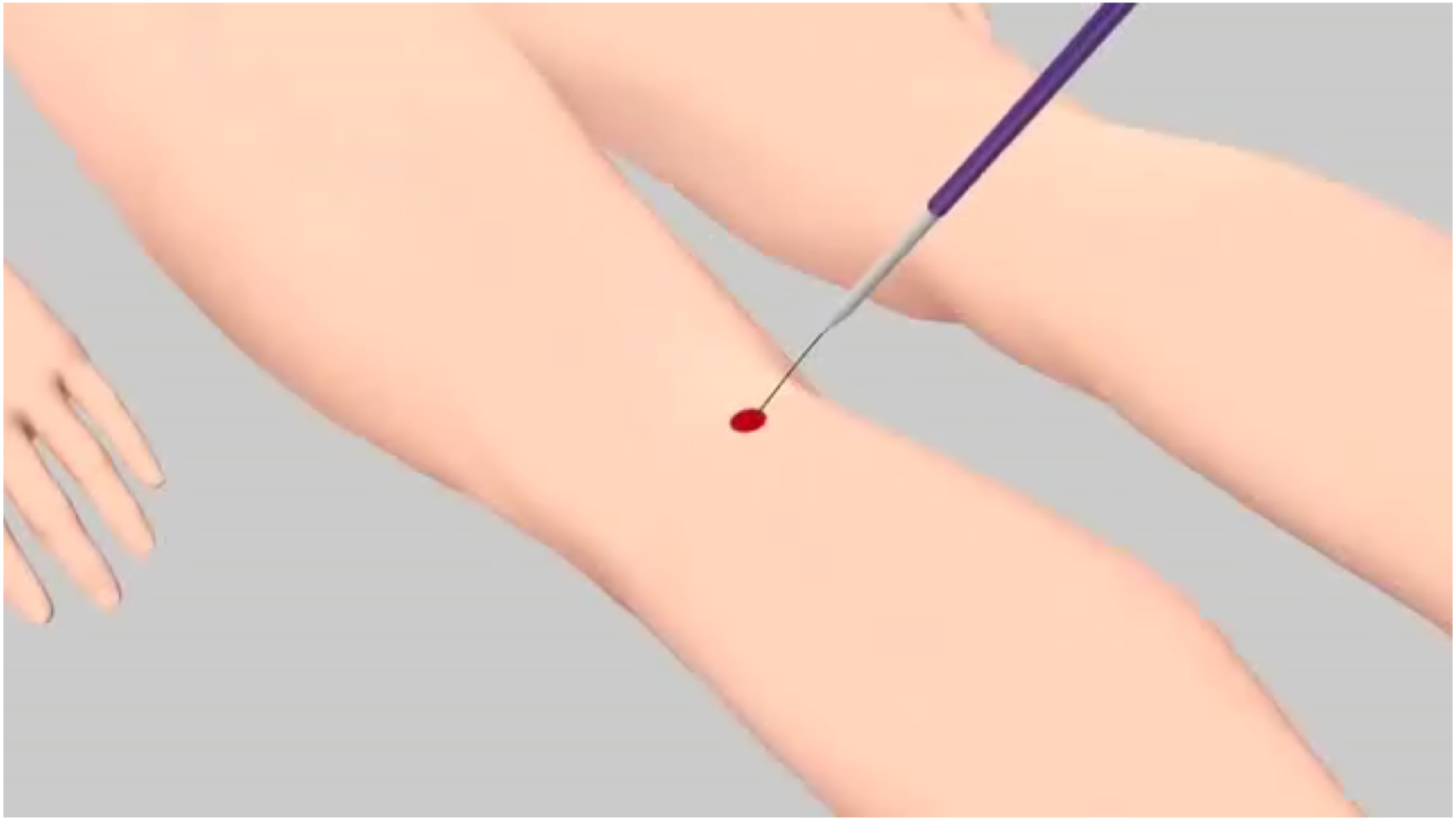
Tests performed and data on file at Penumbra, Inc. Bench test results may not be indicative of clinical performance.

Product availability varies by country. Caution: Federal (USA) law restricts these devices to sale by or on the order of a physician. Prior to use, please refer to the Instructions for Use for Indigo Aspiration System and Penumbra Pump MAX for complete product indications, contraindications, warnings, precautions, potential adverse events and detailed instructions for use. Please contact your local Penumbra representative for more information.

FlowTriever



ClotTriever



XCoil