Venous stents and Hip Biomechanics

Working towards optimizing durability

Kush R Desai, MD FSIR
Associate Professor of Radiology, Surgery, and Medicine
Northwestern University
Chicago, Illinois

Disclosures

- Speakers bureau/consulting: Medtronic Cook Medical, Boston Scientific, Becton Dickinson/CR Bard
- Consulting: Philips, W.L. Gore, OptiMed, Walk Vascular, Tactile Medical, Cardinal Health/Cordis, Shockwave Medical, Asahi Intecc

The problem

- The majority of literature on stent longevity and interactions with hip biomechanics is from the arterial circulation

Arterial Patient

Venous patient

The problem

- Venous stent placement below the inguinal ligament is common
  - Often required in post-thrombotic occlusions to ensure patency from profunda femoris inflow
- VIVO: 22.6%
- VIRTUS: 38%
- VERNACULAR: 9.2%
- ABRE: 44%

Safety and Effectiveness of Stent Placement for Iliofemoral Venous Outflow Obstruction

Systematic Review and Meta-Analysis

- Meta-analysis of 37 studies
- 79% primary patency at 1 year (post-thrombotic)
- 5 year projected primary patency ~60%

Razavi et al. Circ Cardiovasc Interv, 2015

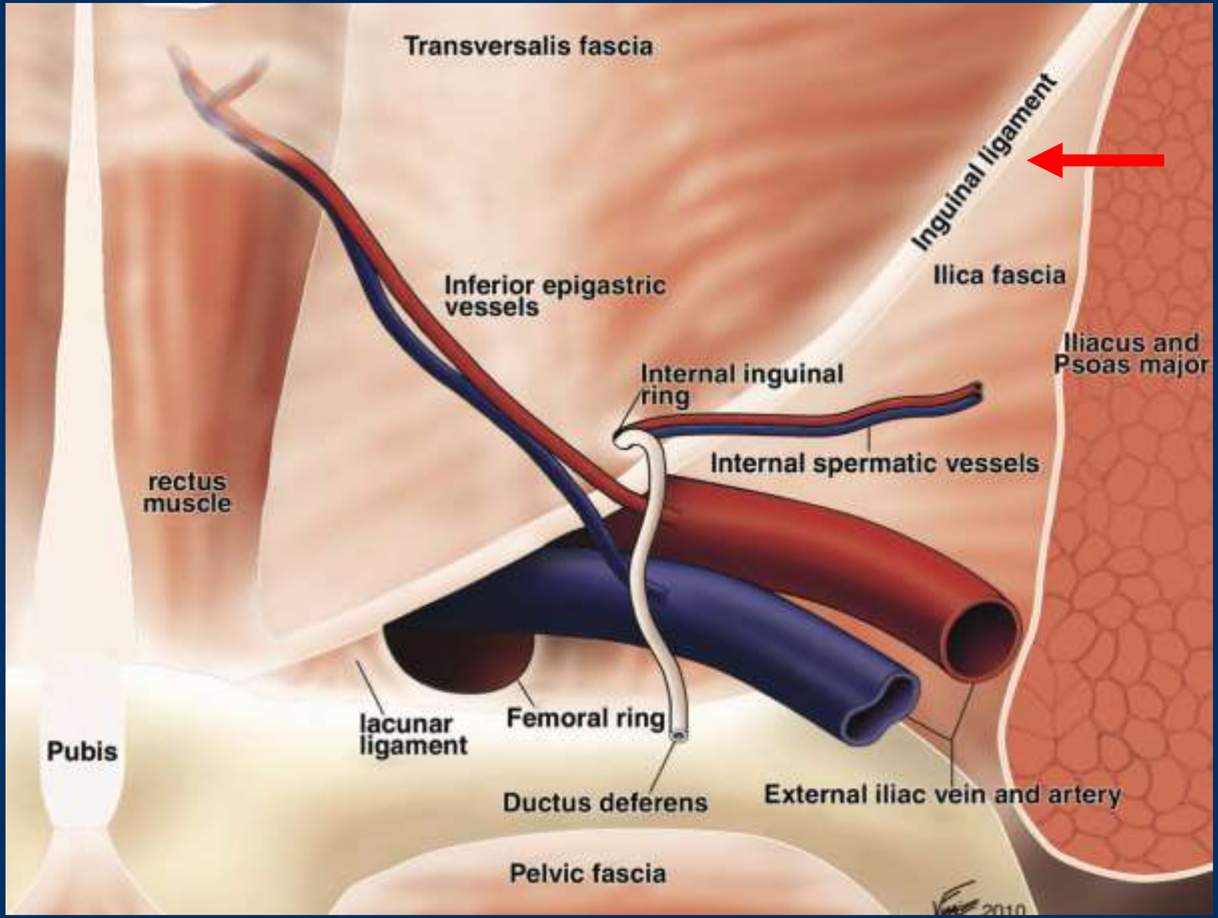
The problem

Investigation of adverse events associated with an off-label use of arterial stents and CE-marked iliac vein stents in the iliac vein: insights into developing a better iliac vein stent

- Review of retrospective data from 2006-2016
- 88 total adverse events from MAUDE and 182 articles
- Stent fracture rate from review of MAUDE: 37%

Shida et al, J Artif Organs 2018

The misconception



The inguinal ligament is NOT the cause of stent failure!

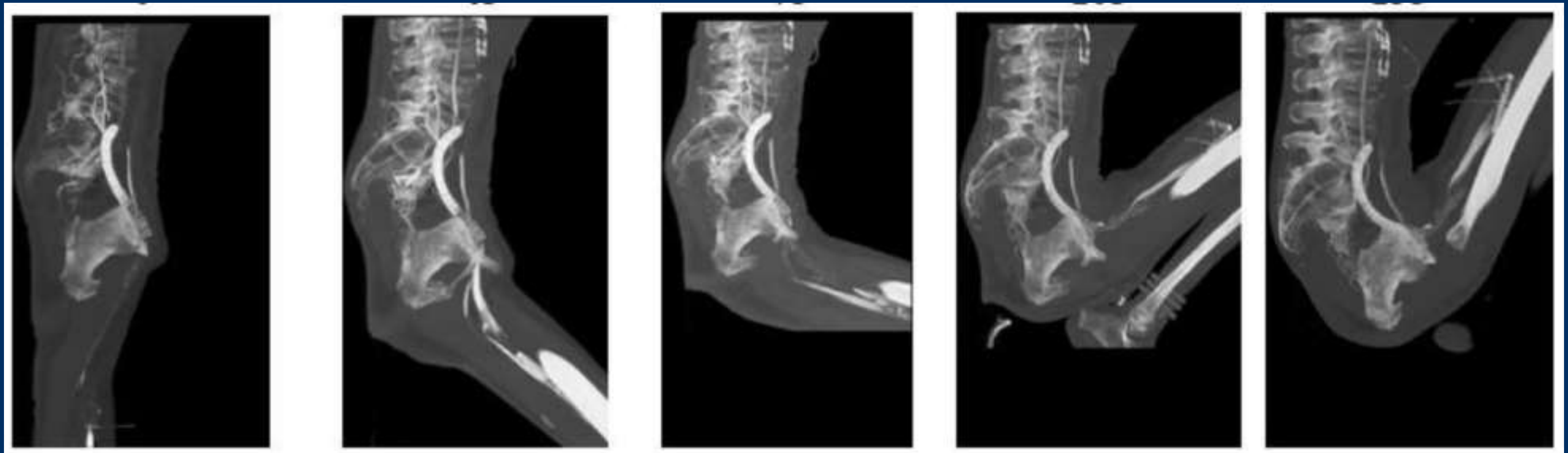
Rethinking the cause

The biomechanical impact of hip movement on iliofemoral venous anatomy and stenting for deep venous thrombosis

- Study examining the impact of hip biomechanics on venous stents
- Cadaveric modeling
- CT imaging in 21 patients before and after iliofemoral stent placement

Cheng et al, J Vasc Surg Ven Lymph 2020

The biomechanical impact of hip movement on iliofemoral venous anatomy and stenting for deep venous thrombosis



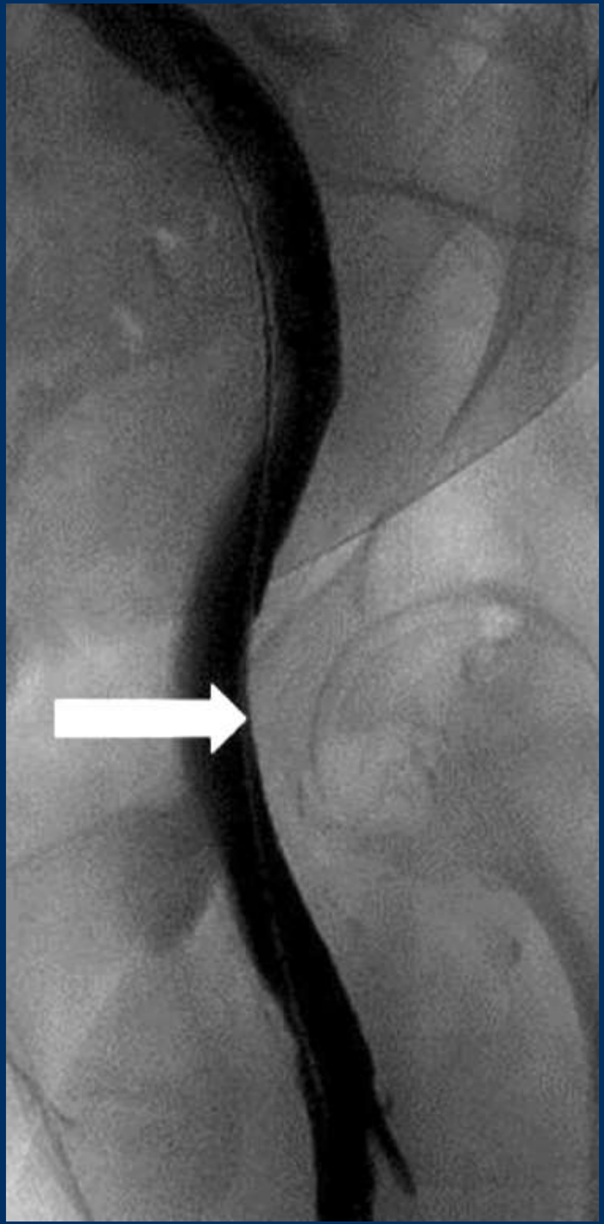
- Cadavers:
  - *Decrease* in compression with 30-75 degree flexion
  - Separation of vein by 1-3 cm from the inguinal ligament

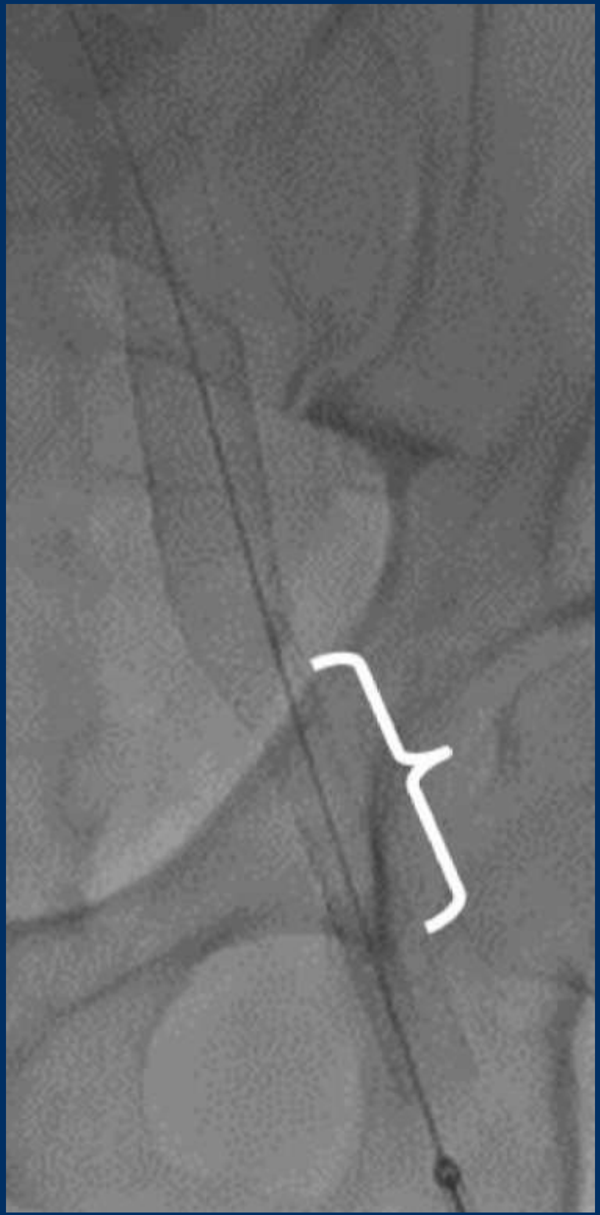
Cheng et al, J Vasc Surg Ven Lymph 2020

The biomechanical impact of hip movement on iliofemoral venous anatomy and stenting for deep venous thrombosis

- Patient study:
  - Vein compressed *posteriorly* by the superior pubic ramus in 47%
  - 78% were within 3 mm of the ramus
  - Conclusion: Maximal stent stress occurs in *extension*

Cheng et al, J Vasc Surg Ven Lymph 2020





Cheng et al, J Vasc Surg Ven Lymph 2020

The next steps…

- Elucidating the mechanism of stent fracture
  - Compression or repeated stress causing metal fatigue?
- Determining whether stent design plays a role
  - Laser-cut nitinol vs braided designs
- Techniques for optimal stent placement
  - Likely differ based on the stent design/material
- Dedicated fatigue testing to ensure device and lumen durability, and minimize need for reintervention
  - Devices have to last for decades in many of these patients

Conclusion

- Disease-specific iliofemoral venous stents are here
- Unique challenges:
  - Patients are younger, device longevity more critical
  - Significant number of devices placed in region of dynamic anatomy
  - Device fracture may have significant consequences
- Recent data demonstrates that stents are affected by the ramus in extension
- Efforts underway to improve our understanding, and ultimately, our tools