What are the characteristics of TAAA patients that make endovascular options more formidable?

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DISCLOSURE

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What is the advantage of a branched endograft?

- Thoraco-abdominal aneurysm repair is, in most cases, a prophylactic operation done to prevent death from rupture
- A branched endograft is a less invasive way of treating TAAA, with presumptively higher reintervention and surveillance needs, and less well established long term durability
- These devices are ideal as tools to treat patients who are higher risk for open repair, but who still are likely to live long enough to enjoy the benefits of protection from rupture

3 Groups of patients are not good candidates for a branched endograft

- Those who would be good candidates for open repair
- Those who are not strong enough for an open repair, but whose anatomy is unsuitable for an endovascular repair
- Those who are unlikely to survive long enough due to other medical comorbidities such that elective repair is unlikely to meaningfully improve their quality or duration of life

Once we've excluded the 20% of TAAA patients who are likely to do well with open repair, there are 2 types of risk that make branched repair formidable:

Anatomic Risk

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Physiologic Risk

Anatomic Risk

Anatomic Unsuitability

- There are few definitive anatomic criteria that preclude branched endovascular repair

- Creative solutions have been developed to overcome many of these criteria using adjunctive procedures in multi-staged repairs

- 4 general types of anatomic challenges:
  1. Seal/fixation
  2. Target vessel anatomy
  3. Access
  4. Mural Atheroma

Seal/Fixation

- With branched endografts, seal can be achieved anywhere from the left carotid to the supra-celiac aorta
- One cannot compromise the seal/fixation, as migration would be catastrophic
- Therefore, we have to balance the risk of increased aortic coverage with a corresponding increased risk of spinal cord injury against the risk of migration and device collapse
- Higher extent aneurysms with increased aortic coverage increases the risk of adverse outcomes, both from spinal cord injury as well as increased inflammatory response and physiologic stress

Target Vessel Anatomy

- The standard anatomic risk factors for any peripheral vascular intervention apply to target vessels in branched endografts:
  - Stenosis
  - Calcification
  - Tortuosity
  - Early bifurcation

- Prior EVAR with supra-renal struts covering the renal arteries

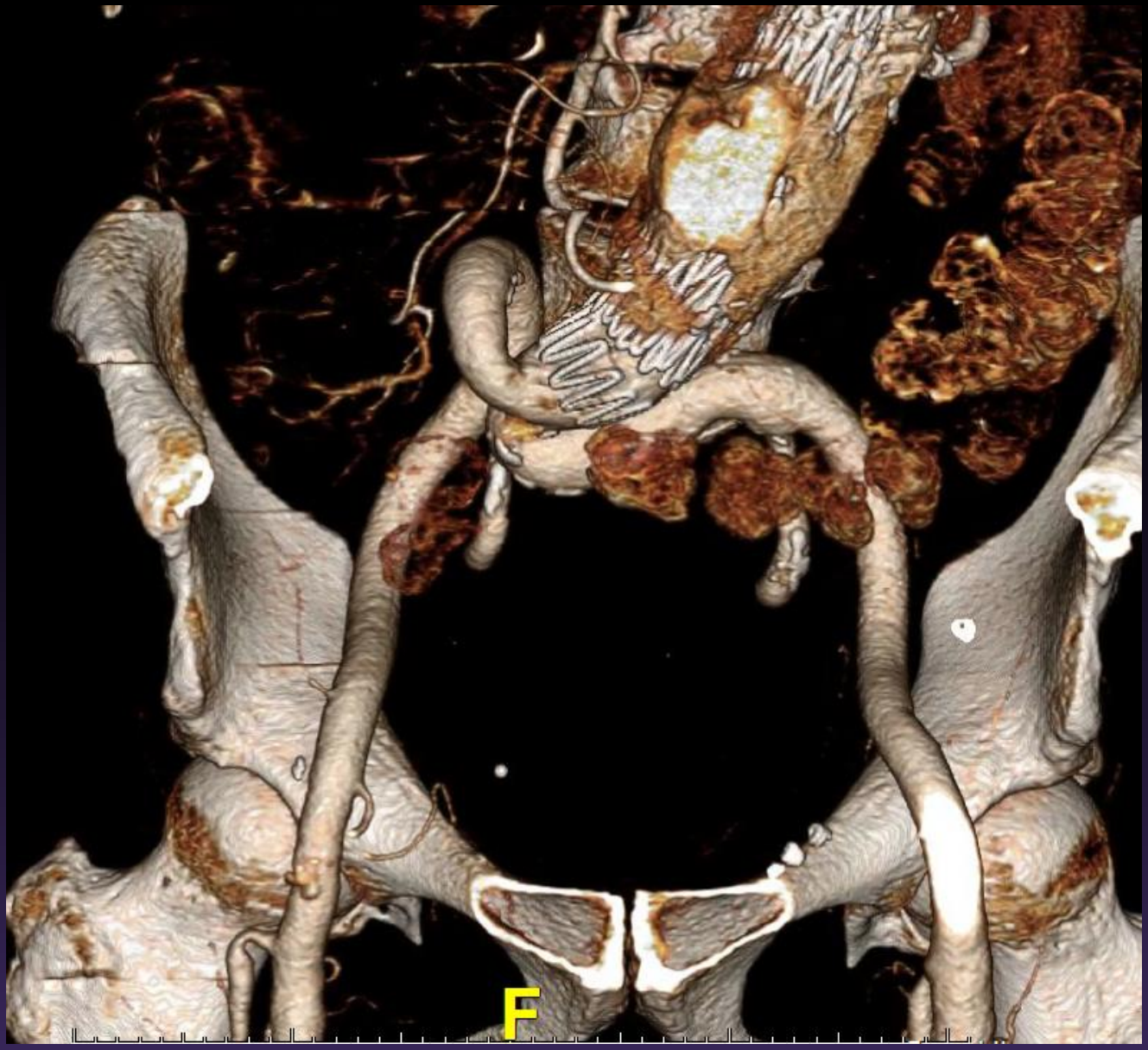
- All vessels must be > 4 mm in size

Access

- Access includes the ability to get the device into the aorta, as well as the ability to rotate/align the device and then navigate through the aneurysm to selectively catheterize the target vessels

- Specific issues include:
  - Iliac access: diameter, calcification and tortuosity
  - Large sac size requiring that the branch traverse a large aneurysm sac
  - Narrow true lumen size due to dissection, limiting the room for wire/catheter manipulation
  - Tortuosity, making rotational control of the device and target vessel cannulation difficult

Access



Mural Atheroma

- Unlike other anatomic features, mural atheroma is a feature for which there is no effective means of remediation
- The Mayo group looked at 212 patients treated with fenestrated and branched endografts
- 53% of those with moderate or severe atheroma had any adverse end point compared to 35% of those with mild atheroma
- Overall, mural atheroma burden was specifically associated with:
  - Slower return of bowel function
  - Worsening renal function
- Interestingly, there was no correlation with stroke or spinal cord injury
- Important to note that this included only patients selected for operation, so those who were not offered operation based on the atheroma were not included and the risk of atheroma is therefore likely under-reported

Rubiero JVS 2017

Mayo Mural Atheroma Grades

Rubiero JVS 2017

Anatomic Unsuitability

- An easy analogy for branched graft anatomic unsuitability is that of iliac anatomy and EVAR. We generally assess: tortuosity, diameter and calcification

- These aortic and branch vessel anatomic criteria are additive. One or two issues is rarely a problem, but the presence of multiple anatomic challenges greatly increases the procedural complexity and risk for adverse outcome

- Again, as we've seen with EVAR, attempting endovascular repair in a patient with unsuitable anatomy often results in adverse outcomes

Physiologic Unsuitability

Physiologic Unsuitability

- Among patients treated with branched endografts, 10-20% experience serious adverse outcomes after repair, meaning they do not return to their pre-operative functional state and suffer permanent loss of organ function, such as dialysis, paralysis, death, etc.

- As is true of any major operation, a significant determinant of outcomes is the patient's baseline physiologic reserve

Physiologic Unsuitability

- All patients getting a branched endograft suffer from various degrees of chronic illness and have limited life expectancy

- The Cleveland Clinic has reported the longest term follow up:
  - Among 610 patients treated for juxta-renal or type 4 TAAA, survival was 60% at 5 years
  - Among 354 patients treated for type 2/3 TAAA: survival was 40% at 5 years

- Note that each of these patients was selected for repair, so this does not account for survival among those not treated

Mastracci JVS 2015
Eagleton JVS 2016

Physiologic Unsuitability

- Any end-stage organ failure is a general contra-indication:
  - End-stage heart failure requiring hospitalization
  - COPD on home O2 continuously
  - ESRD on dialysis
  - Hypoalbuminemia/weight loss/malnutrition
  - Dementia

- Frailty
  - This is not a cumulative summary of medical co-variates, but rather a direct measure of a patient's independent functional status and physiologic reserve
  - Measured by the Clinical Frailty Scale

- Other terminal medical diagnosis:
  - Malignancies are most common

Physiologic Unsuitability

In a UW study of 432 patients with TAAA, we attempted to quantitate physiologic fitness using 2 criteria:

1) “Significant comorbidity”

2) Pre-op Exercise Tolerance

"Significant Comorbidity"

- "Significant comorbidity" (any 1 or more of the following)
  - Dependent functional status
  - Untreated malignancy
  - COPD on home O2
  - Dialysis
  - Active substance abuse
  - Unintentional Weight loss > 10% BMI
  - Dementia
  - BMI <18.5 or >40
- 33% of the overall cohort met this criterion
  - 15% of patients who had repair of one type or another
  - 51% of those who did not have repair

Exercise Tolerance

- Pre-op Exercise Tolerance:
  - Low: METS < 3 (slow walking)
  - Moderate: METS 3-6 (light exercise, e.g. stationary bike at low/mod intensity)
  - High METS > 6 (high intensity exercise, heavy labor, chopping wood, etc)

- Exercise Tolerance in UW Cohort Study:
  - Low - 49%
  - Moderate - 33%
  - High - 18%

Summary

- Branched endografts are one tool in the toolkit of an aortic surgeon
- We need to ensure that we don't overuse that tool for those patients who would do well with open repair which has a better track record of durability and avoidance of reintervention
- Among those who would not do well with open repair, we need to exclude those with either:
  - Anatomic unsuitability: cannot overcome certain anatomic limitations to safely do the procedure
  - Physiologic unsuitability: too ill, frail to expect a benefit of a high risk, high cost prophylactic operation