Aortoiliac stenting: is CERAB replacing kissing stents from a flow dynamic perspective?

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Disclosure

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I have the following potential conflicts of interest to report:
- [ ] Consulting
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [ ] Other(s)

- [ ] I do not have any potential conflict of interest
Aorto-iliac occlusive disease

- Open surgical repair is current standard for complex aorto-iliac occlusive lesions
- 5-year patency rate 87 - 91%
- Complication rate 8 - 12%
- Mortality rate 4%
Late complications of open repair

Incisional hernia
- Incidence: 11%
- Complication rate: 24-30%
- Recurrence rate: 2-10%

 Postsurgical adhesions
- Incidence: 67-93%
- Small bowel obstruction
- Inadvertent enterotomty: 19%

Extensive aortoiliac occlusive disease

Endovascular options:

• Kissing stents and/or double barrel bare metal stents

• Kissing covered stents

• Use of AAA devices

• Covered endovascular reconstruction of the Aortic Bifurcation (CERAB)

Case courtesy of Dr Mangialardi-Ronchey, San Filippo Neri Hospital, Rome
Lesions of the aortic bifurcation and Kissing Stents

- Broad range in patency of kissing stents
- Inferior compared to isolated stents in iliac artery or the aorta
- Patency affected by:
  - **Radial mismatch**: aortic lumen dead space around the protruding segment of the stents
  - Differences in **stent conformation**
  - The overlap of the free proximal stent ends
    - Re-circulation, turbulence and stasis
    - Mesenchymal tissue, thrombus and intimal hyperplasia

Covered Endovascular Reconstruction of the Aortic Bifurcation - CERAB

Goal: to provide a more anatomical and physiological endovascular reconstruction of the aortic bifurcation
Results CERAB Antwerp and Arnhem

- February 2009 – March 2014
- 103 elective patients
- Acute cases (n=5) and chimney’s (n=5) excluded
- 61 (36-85) years
- Rutherford classification:
  - 1 (n=1) 1%
  - 2 (n=0) 0%
  - 3 (n=64) 62%
  - 4 (n=20) 19%
  - 5 (n=17) 17%
  - 6 (n=1) 1%

- Technical success 95%

Results CERAB Antwerp and Arnhem

- ABI 0.64 ± 0.21
- TASC -2
  - B n=5 (6%)
  - C n=9 (9%)
  - D n=88 (86%)
- Risk factors:
  - Smoking n=89 (87%)
  - Hypertension n=78 (76%)
  - Diabetes n=29 (29%)
  - Dyslipidemia n=91 (88%)
  - Coronary artery disease n=43 (42%)
  - Pulmonary disease n=46 (45%)
  - Renal disease n=18 (18%)

Results CERAB Antwerp and Arnhem

- 30-day mortality 0%
- 30-day complication rate 23%
  - Hematoma groin (n=16)
  - Re-bleed (n=1)
  - Pseudoaneurysm (n=2)
  - Fever eci (n=2)
  - Atrial fibrillation (n=1)
- 30-day major complication rate 2%
  - Renal failure (n=1)
  - Pneumonia (n=1)
- ABI 0.91 ± 0.14
- Admission 2 days (range 1-16 days)

Results CERAB Antwerp and Arnhem

- Median follow-up 12 months
- Primary patency
  - 6 months 92%
  - 12 months 87%
  - 18 months 87%
- Secondary patency
  - 6 months 98%
  - 12 months 95%
  - 18 months 95%
- Limb salvage 100%

Covered Endovascular Reconstruction of the Aortic Bifurcation - CERAB

CERAB related to:

• Lowest radial mismatch
• High conformation ratio ('double-D' configuration)

Methods

**flow setup**

- **Physiological flow model:**
  - Based on second order windkessel model
  - Peak flow 60 mL/sec
  - Flow equal to all out flow vessels
  - 120/80 mmHg, 60 BPM
  - Blood mimicking fluid: 4.3 cP
- Flow fields obtained with laser particle image velocimetry (PIV)
- Stent cover made transparent
Methods

configurations

Kissing bare stents

Kissing covered stents

CERAB
Results

inflow section limbs
Results, flow fields at neobifurcation

- Flow perturbation little to none at in flow of KS BM configuration
Covered KS mismatch induces large zone of recirculation during entire cardiac cycle.
Results

WSS inflow section limbs

- Low WSS in covered KS configuration, over the entire vessel wall
- WSS values CERAB comparable to KS bare metal stents
Results

inflow section CERAB cuff

No flow perturbations at the inflow of aortic cuff
Results

native aortic bifurcation
Results

*native aortic bifurcation*

- Continuous zone of low flow between anatomic bifurcation and neobifurcation
- End systolic phase: recirculation at the mismatch area
Results

WSS native aortic bifurcation

- WSS control and bare metal KS configuration comparable
- WSS bare metal KS configuration at the end systolic closer to zero
Conclusion

- The CERAB configuration is related to undisturbed flow throughout the cardiac cycle.
- Inflow section of limbs is disturbed in the covered KS configuration:
  - Large recirculation zones when compared to CERAB.
  - Low WSS throughout cardiac cycle compared to CERAB and bare metal KS.
- Bare metal KS related to recirculation and slow blood flow at the native bifurcation:
  - Correlated to thrombus formation and intimal hyperplasia in this zone.
  - This zone excluded in the CERAB configuration.
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