SINGLE CENTER EXPERIENCE WITH PIPELINE STENT: FEASIBILITY, TECHNIQUE, AND COMPLICATIONS
## HISTORY OF ENDOVASCULAR TREATMENT

- **14th century Egypt**

- **19th century**
  - Inserting needle to provoke clot in aneurysm
  - Fibrin formation around bullet lodged in thoracic aorta

- **20th century**
  - Luessenhop and Velasquez—inflatable catheter (balloon)
  - 1965—Magnetic field guidance of Iron Spheres
  - Detachable balloons

- **Late 20th century**
  - 1992—Guglielmi detachable coils—platinum coils released from stainless steel wire through electrolysis when current applied to wire
Late 20<sup>th</sup> century—21<sup>st</sup> century
- 1997—Moret—balloon-assisted coiling
- Onyx

Stent-assisted coil embolization
- Wide-necked aneurysms

Aneurysm recurrence rates range from 15% in completely occluded aneurysm to 46% in cases with residual sac filling
Is there another way that is more effective with the benefits of remaining minimally invasive/morbid?
Flow Diversion

- Stent placed across neck of aneurysm
  - Decrease blood flow into aneurysm
  - Redirect flow along parent vessel

Process:
- Stasis within aneurysm $\rightarrow$ thrombosis
- Scaffold for neointimal proliferation $\rightarrow$ remodeling of parent artery
CONCEPT

- Anatomical Changes
  - New configuration of parent artery-aneurysm complex
  - Changes in aneurysm inflow zone
  - Reconstructs circumferentially diseased segments of vessels

- RESULT: Restoration of a normal vessel wall with normal hemodynamic flow
Multi-alloy stent with higher percentage metal surface coverage than conventional stents
- 25% platinum
- 75% cobalt-nickel alloy
- Provides 30-35% metal coverage of inner surface of target vessel
  - Neuroform Stent 6.5-9.5% metal coverage
- Improves capacity to affect physiologic changes
CASE SERIES

- Series of PED embolization in “Real World” setting
- FDA approval in April 2011
- 36 patients treated
STUDY DESIGN

- Retrospective Review
- 36 patients with 42 aneurysms
- Types of aneurysms treated
  - Complex, fusiform, wide-necked (dome:neck < 2 or neck ≥ 4mm)
  - Giant, saccular, non-saccular
  - Anterior and posterior circulation
Medications:

- For at least 10d prior to intervention:
  - Plavix 75mg qday
  - ASA 81 mg qday

- For 6 mo following intervention:
  - Plavix 75mg qday, then stop
  - ASA continued indefinitely
TECHNIQUE

- Triaxial loading system
- PED introduced through microcatheter
- PED unsheathed
- Forward pressure with microcatheter to obtain “cigar” or “pillow-case” shape
Pipeline® Device Deployment: Creating the Cigar

Initial opening of device before vessel wall opposition is achieved.

The ideal cigar. Notice the deployment angle.

Too much unsheathing of micro catheter may lead to temporary stretching. Notice the deployment angle.

Too much forward push on micro catheter. Notice the deployment angle.
Microcatheter is pushed forward while delivery wire is held in place to pack PED

 Necessary to engage stent to vessel wall and prevent endoleak
TECHNIQUE-DEPLOYMENT
- Torque device attached to wire is rotated clockwise 3 times to detach wire from distal tip of the stent

- Wire is removed
36 patients (3 male, 33 female; age 34-82, mean 60.1)

Clinical Presentation
- 12 HA
- 7 Cranial nerve deficits
- 2 TIA
- 1 SAH
- 8 Incidental
- 5 Recurrence after coil embolization
- 1 Recurrence after PED embolization
- 1 after failed coil embolization
40 of 42 aneurysms in segments of ICA

- 1 petrous
- 1 lacerum
- 15 cavernous
- 2 clinoid
- 14 ophthalmic
- 4 superior hypophyseal

1 dissecting fusiform aneurysm at M2

1 recurrent VB aneurysm previously treated with stent-coil embo
2 Giant aneurysms (≥25mm)
16 Large aneurysms (10-25mm)
24 Small aneurysms (<10mm)
34(81%) with wide-neck morphology
Mean size 11.1mm
Immediate Angiographic Evaluation

- PED embolization does not result in immediate occlusion

- 100% showed stasis of contrast within aneurysm with alteration of blood-flow patterns and eradication of jet stream into aneurysmal sac

- No occlusion of afferent or efferent vessels related to aneurysm
- No angiographically evident periprocedural thromboembolic events
ANGIOGRAPHIC RESULTS – ECLIPSE SIGN
PED EMBOLIZATION OF DISSECTING FUSIFORM M2 ANEURYSM
Remote angiography reveals remodeling of vasculature and restoration of normal anatomy
COMPLICATIONS

- Postoperative complications = 13.9 % (n=5)
  - 4 symptomatic ICH
  - 1 dissection
  - 2 symptomatic stroke
    - 1 CRAO
  - 1 death
COMPLICATIONS – CONTRALATERAL ICH
COMPLICATIONS – CONTRALATERAL ICH
NUMBER OF STENTS

- Successful technical deployment in 100% of attempts (n=68)
- Number of stents used:
  - 1 stent = 14 patients
  - 2 stents = 16 patients
  - 3 stents = 3 patients
  - 4 stents = 2 patients
  - 5 stents = 1 patient
- Mean number of stents = 1.91
USE OF MULTIPLE STENTS

- Risk of losing patency in vessels emanating from parent artery
  - Occlusion of anterior choroidal during treatment of PCOM aneurysm
  - Occlusion of perforators during treatment of basilar aneurysm
- Occlusion of flow to functional side-branches without evidence of collateral perfusion may result in stroke
Use of antiplatelet medications may exacerbate hemorrhagic complications

Antiplaletet treatment may preclude PED usage in ruptured intracranial aneurysms

Thromboembolic risk can be minimized by avoiding dissection, initiating effective antiplatelet regimen, and using proper number of stents (increased number of stents poses hypothetical risk by decreasing luminal diameter and increasing thrombogenic material in parent vessel)
PED to treat any shape aneurysm, including aneurysms otherwise untreatable by other endovascular means

- Long term data needed
  - Permanence of occlusion
  - Risk of delayed complications, eg in-stent thrombosis
  - Potential to improve symptoms related to mass effect (cranial neuropathies)

- THE REVOLUTION
  - Conceptual shift in way we treat aneurysms
REFERENCES


