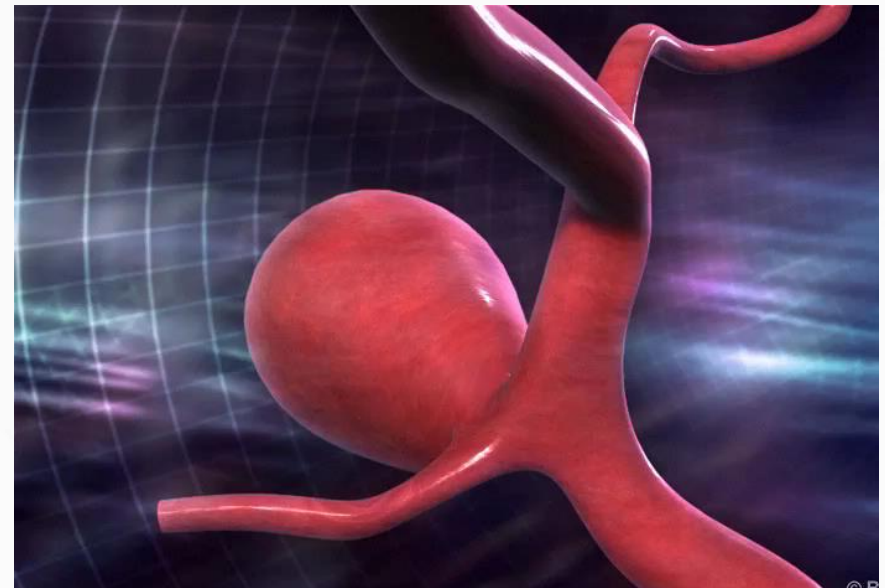


# Brain Aneurysm Surgery: Welcome to 2023

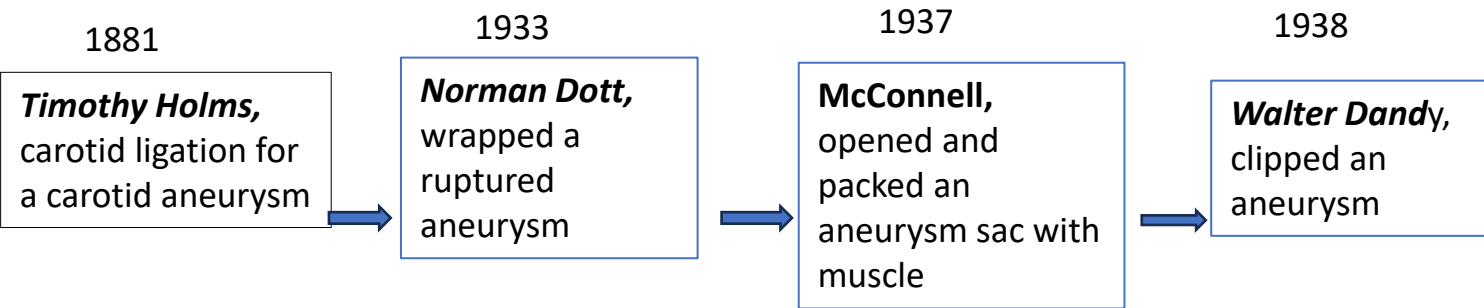
P. Roc Chen, MD, FACS, FAANS  
Professor in Neurosurgery  
Memorial Hermann Chair  
Department of Neurosurgery  
University of Texas McGovern Medical School at Houston  
9/22/2023



# Disclosure

- Stryker Neurovascular research grant.
- Balt Neurovascular research grant.
- NIH research grants.

# Brain Aneurysm

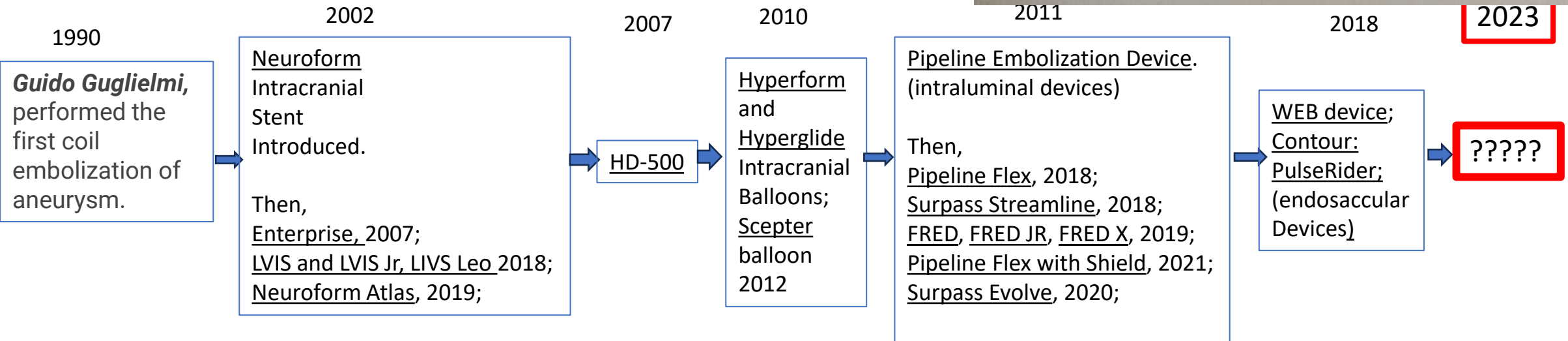


The results of the series in the past 6 $\frac{1}{4}$  years are as follows:

Type of Aneurysm	Number of Cases	Cured	Probably Cured	Not Treated	Dead
Carotid Canal .....	10	9	0	0	1
Internal Carotid (intracranial) .....	16	9	1	1	5
Anterior Cerebral .....	4	2	0	1	1
Middle Cerebral .....	1	0	0	0	1
Posterior Communicating .....	1	0	0	0	1
Posterior Cerebral .....	0	0	0	0	0
Basilar and Vertebral .....	4	0	0	4	0
<b>Total .....</b>	<b>36</b>	<b>20</b>	<b>1</b>	<b>6</b>	<b>9</b>

The mortality rate therefore is 25 per cent; cures from the total number of operations, 55.5 per cent, plus one additional probable cure; in 16.8 per cent there was no attempted treatment (except that in one the vertebral artery was ligated). If the number of aneurysms in which operative treatment was attempted (30 cases) is used for this statistical basis, the cures are 70 per cent. It is believed that, with due appreciation of the errors of the past, the subsequent results should be improved.

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# Aneurysm Treatment \_ RCT

- International Subarachnoid Aneurysm Trial (ISAT)\*

- Clipping N=1070 vs. Coiling N=1073

Poor outcomes at 1 year:

- Clipping 30.9% vs. Coiling 23.5%

Re-bleeding rate:

Clipping (n=3) < Coiling (n=10)

\* *Lancet*, Oct., 2002 and Sept., 2005;

- The Barrow Ruptured Aneurysm Trial (BRAT)\*\*

- Clipping N=238 (209 assigned) vs. Coiling N= 233 (199 assigned)
- 38% (75/199) assigned to coil crossed over to clip
- 1.9% (4/209) assigned to clip crossed over to coil

Poor outcomes (mRS >2) At 1 year:

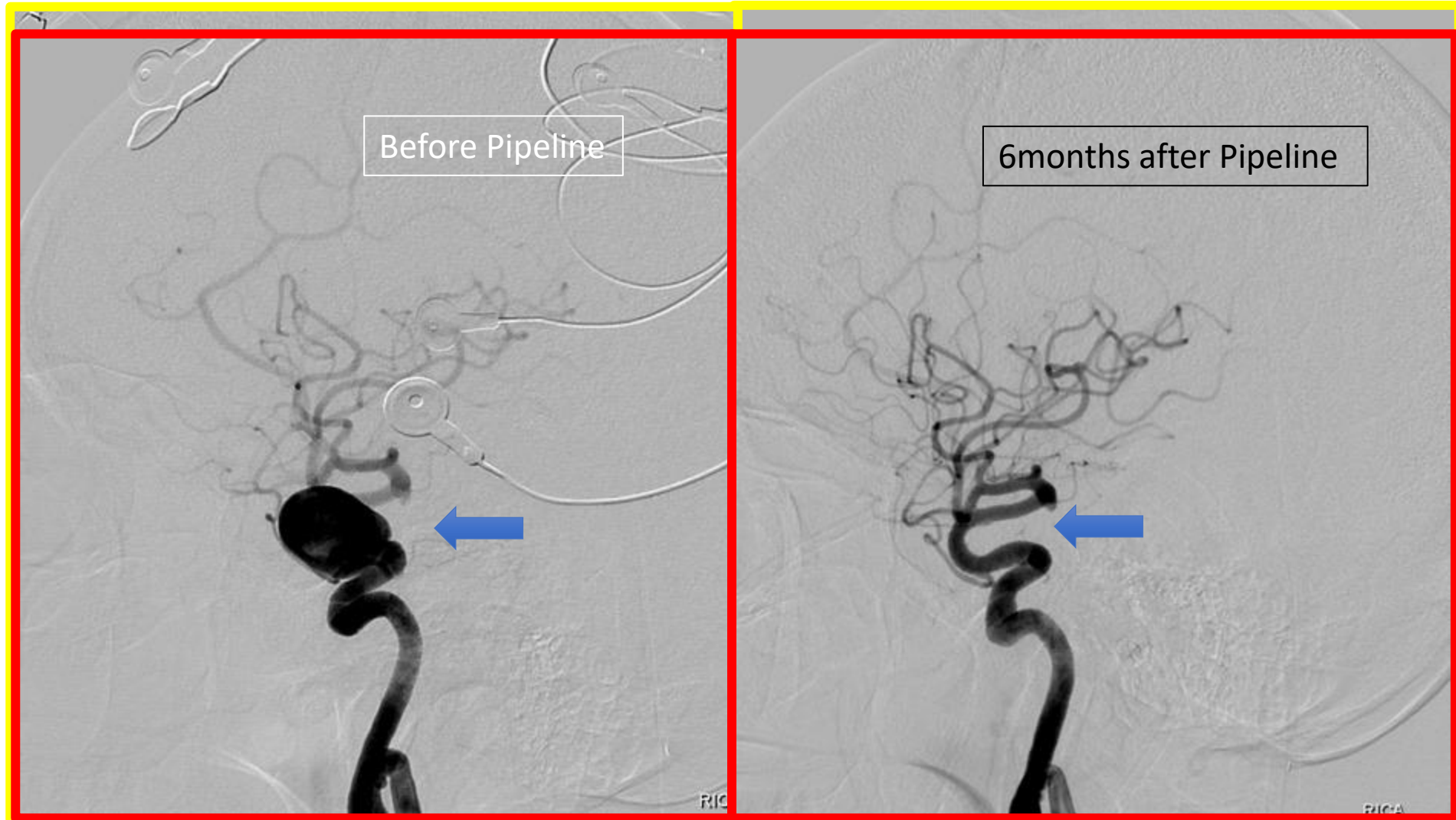
- Clipping 33.7% vs Coiling 23.2%
- Re-bleeding rate: No difference

\*\* *J Neurosurgery*, Jan., 2012

# Case example: Pipeline Embolization Device for a giant ICA aneurysm

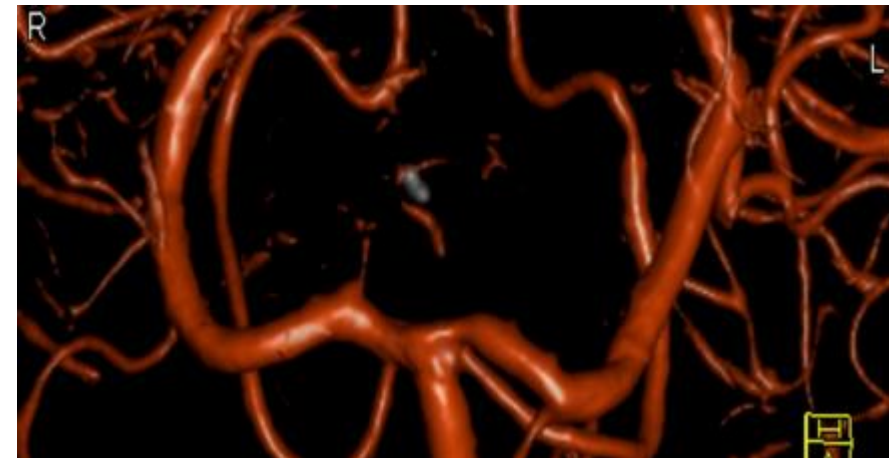
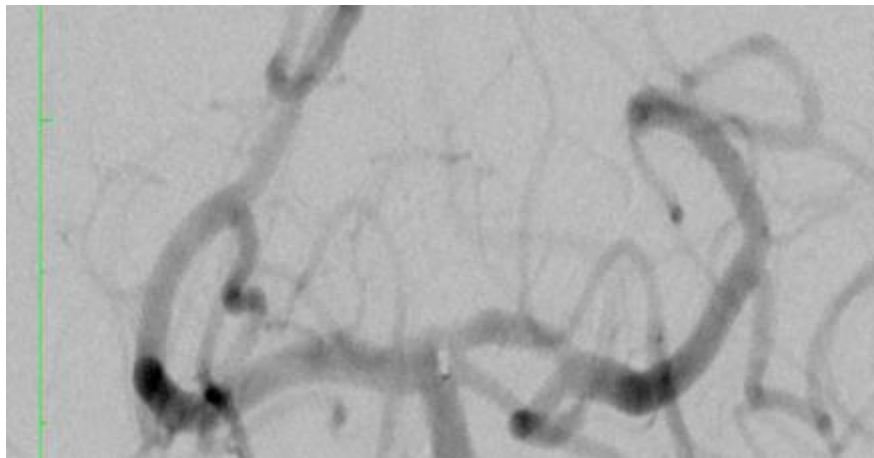
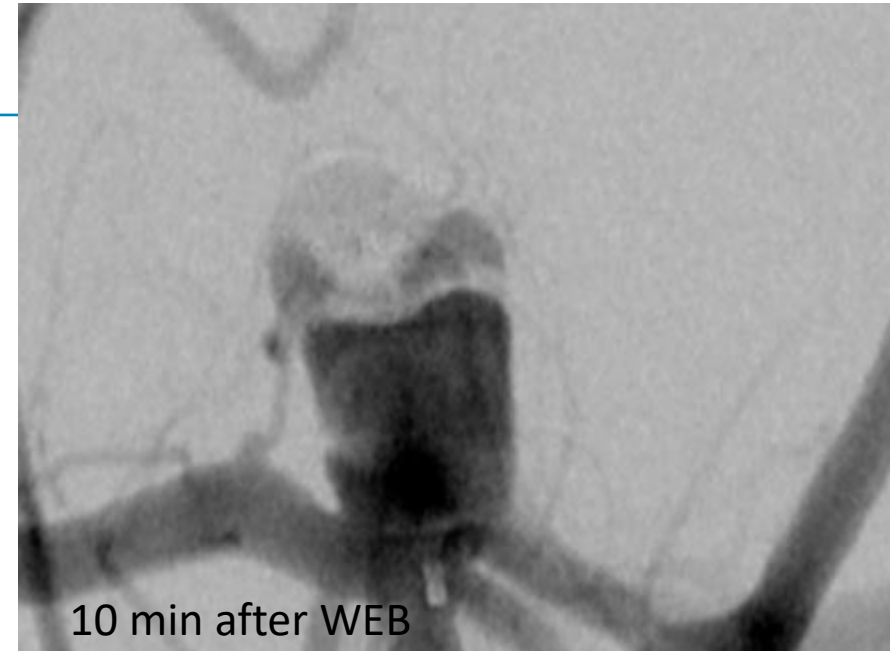


6 month f/u



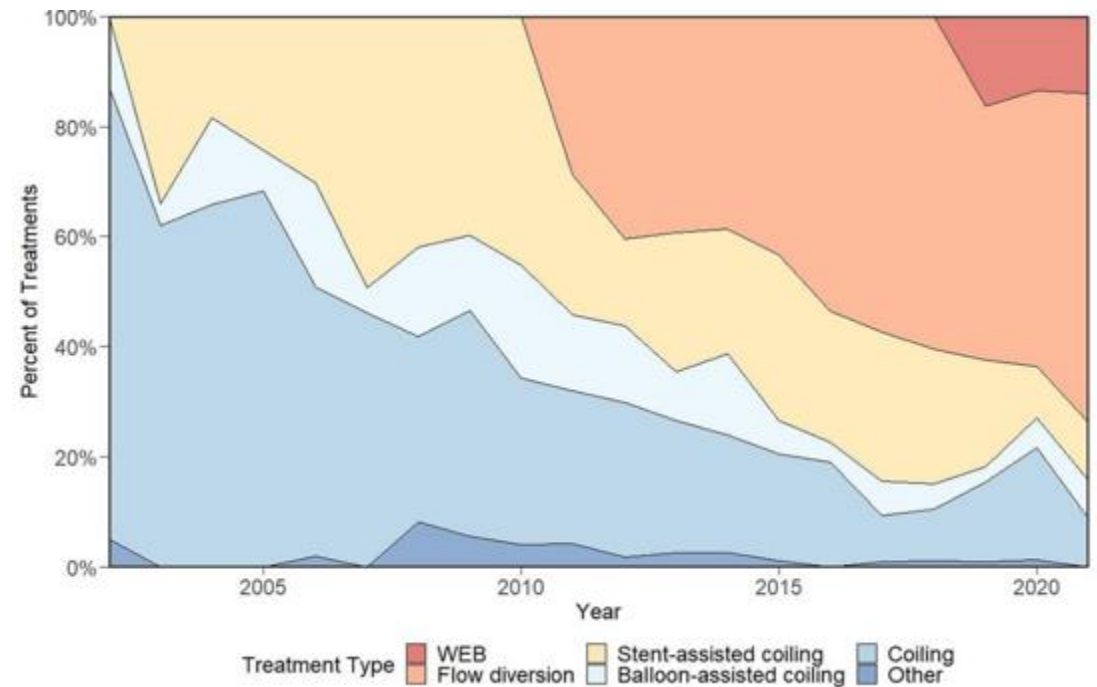


# Case example: Basilar Tip aneurysm, WEB device



# Brain aneurysm treatment has changed drastically since year 2002, Risk reduction

- Endovascular therapy has been the treatment of choice for 60 -70% of aneurysms
- Open surgery are typically performed in situation of complex aneurysm and parent artery anatomy not suitable for endovascular therapy, or a very small percentage cases need bypass revascularization.
- Endovascular therapy has expanded beyond coiling.

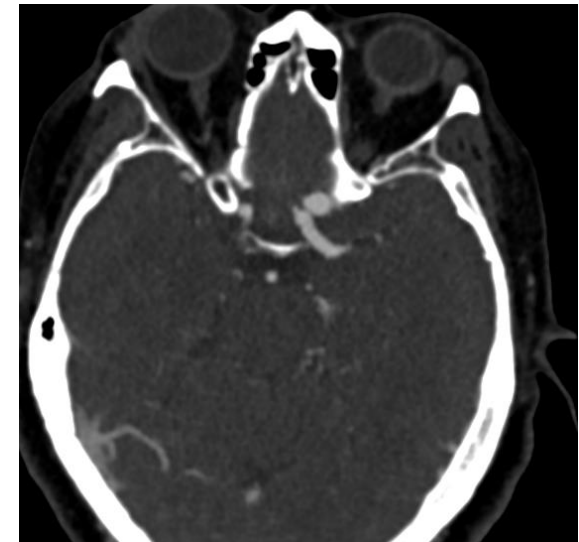
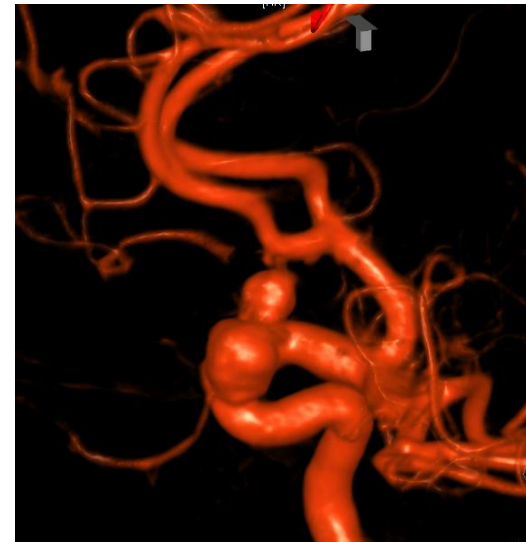
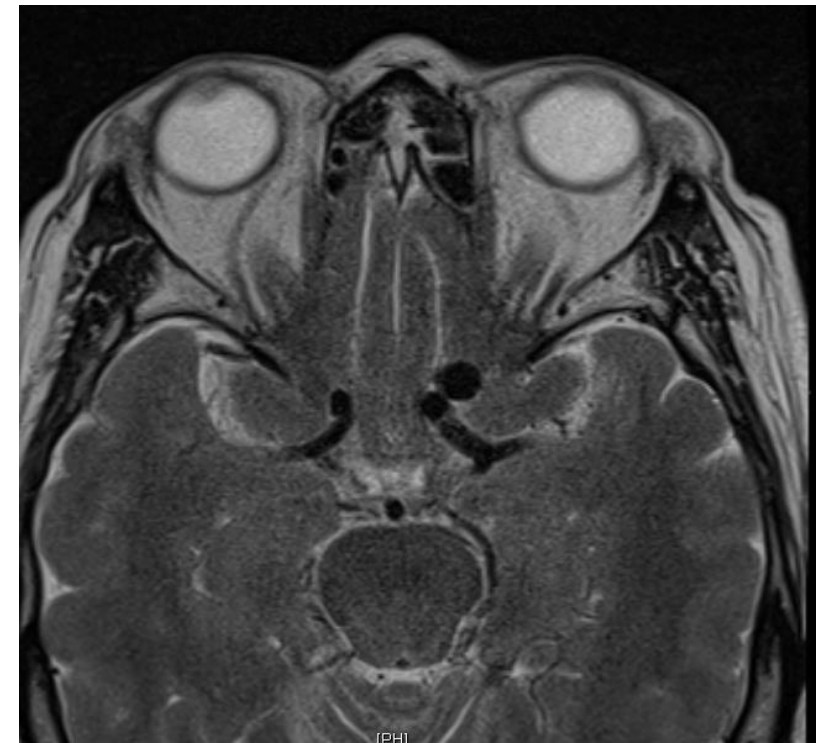




# More patients with unruptured brain aneurysms discovered nowadays

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- More and more small unruptured aneurysms discovered incidentally: MRI for HA, CT and CTA for minor head trauma, or stroke work-up, etc.
- Remember, 2 – 5% popular have brain an aneurysm.



# More treatment options for aneurysms

Coiling (with or without balloon assistance)

Stent assisted coiling

Intraluminal flow diversion devices: Pipeline, Surpass, Silk, FRED X...

Intrasaccular devices: WEB, Contour...

Open surgical clipping

Bypass revascularization with parent artery sacrifice.

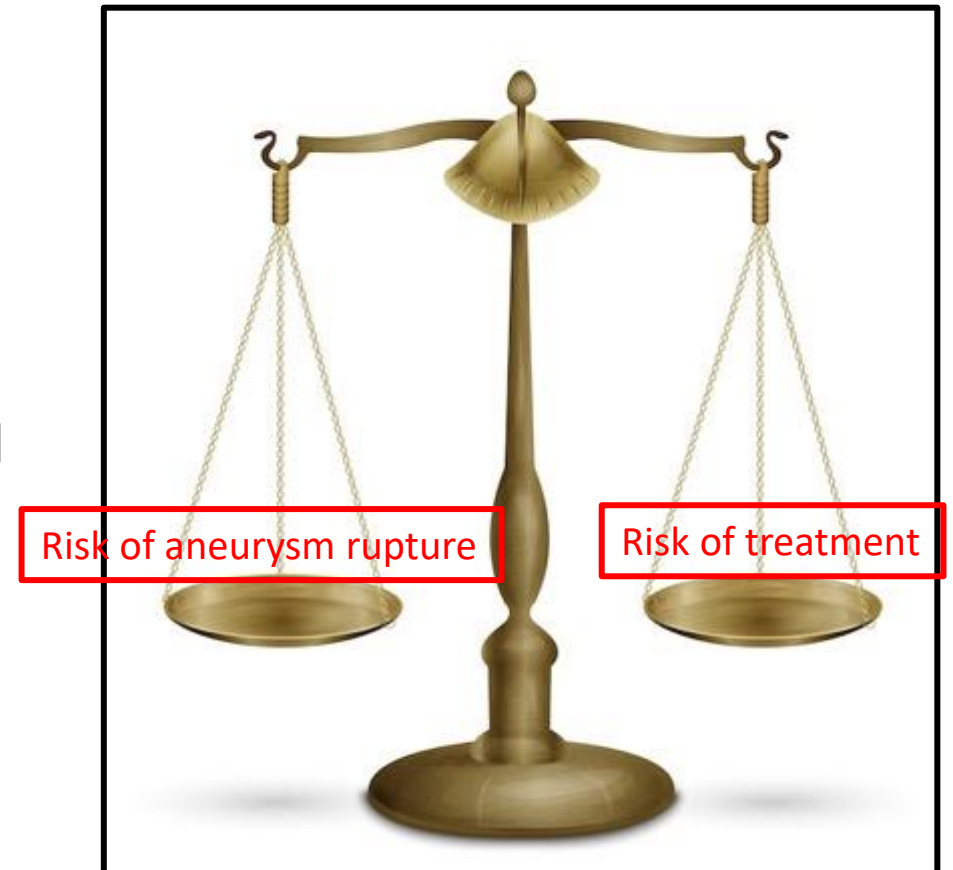
# However, Aneurysm Treatments Carry Risks

	morbidity	mortality	author
Diversion Device (Pipeline, Surpass)	ischemia 4 - 7%; hemorrhage 0 - 3%		Feigen et al, 2022
• FRED	3.90%	1.40%	Waqas et al
Woven EndoBridge (WEB)	6.5% + 3.1%	1%	Mantilla et al, 2023
Flow diversion device for bifurcation aneurysms	22%		Kashkoush et al, 2023
Coil	12%	1%	ISUIA
Clip	12%	3.80%	ISUIA
Coil	10%	0.40%	Johnson et al
Clip	18.50%	2.30%	Johnson et al

# So, An old question, and a key focus of aneurysm treatment in 2023...

---

- Decision of Treatment vs. Conservative management on patients with unruptured small aneurysms given the **aneurysm Rupture Risk** and the potential **Treatment Risk**
- How to meaningfully observe or monitor a unruptured aneurysm? When and why to proceed for treatment?



# ISUIA suggest small aneurysms carried very little risk of rupture

## Unruptured Aneurysms: Rupture Risk

- ISUIA (International Study of Unruptured Intracranial Aneurysms)
  - 4060 patients
    - 1692 no repair
    - 1917 open surgery, 451 endovascular repair
- Tsutsumi et al
  - Retrospective data on 62 patients followed for mean of 4.3 years
- Juvela et al
  - Retrospective data on 142 patients with 181 aneurysms followed for median of 19.7 years

	<7 mm		7-12 mm	13-24 mm	≥25 mm
	Group 1	Group 2			
Cavernous carotid artery (n=210)	0	0	0	3.0%	6.4%
AC/MC/IC (n=1037)	0	1.5%	2.6%	14.5%	40%
Post-P comm (n=445)	2.5%	3.4%	14.5%	18.4%	50%

AC=anterior communicating or anterior cerebral artery. IC=internal carotid artery (not cavernous carotid artery). MC=middle cerebral artery. Post-P comm=vertebrobasilar, posterior cerebral arterial system, or the posterior communicating artery.

Table 4: 5-year cumulative rupture rates according to size and location of unruptured aneurysm

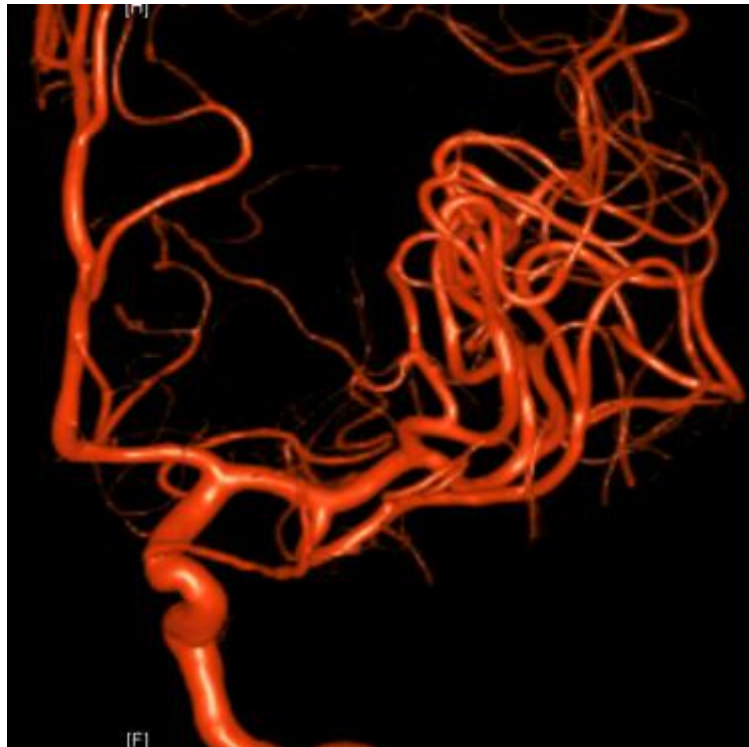


## Case example, a ruptured tiny aneurysm

- 69 yrs old female presented with HH 3 SAH on 9/11/2023.



At admission



At admission, 3D DSA



7 days later, 3D DSA

# Small unruptured aneurysms do rupture

The NEW ENGLAND JOURNAL of MEDICINE

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ORIGINAL ARTICLE

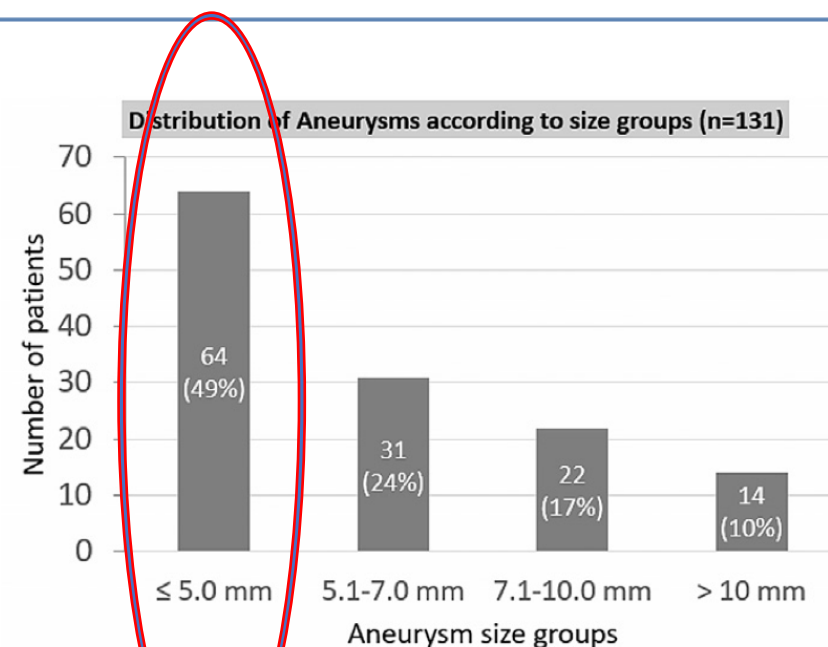
## The Natural Course of Unruptured Cerebral Aneurysms in a Japanese Cohort

The UCAS Japan Investigators\*

Risk Factor	Hazard Ratio (95% CI)	P Value
Female sex	1.54 (0.99–2.42)	0.05
Age ≥70 yr	1.21 (0.81–1.78)	0.34
Hypertension	1.41 (0.96–2.07)	0.08
Hyperlipidemia	0.54 (0.28–1.03)	0.06
Daughter sac	1.63 (1.08–2.48)	0.02
Largest dimension of aneurysm		
3–4 mm	Reference	
5–6 mm	1.13 (0.58–2.22)	0.71
7–9 mm	3.35 (1.87–6.00)	<0.001
10–24 mm	9.09 (5.25–15.74)	<0.001
≥25 mm	76.26 (32.76–177.54)	<0.001
Location of aneurysm		
Middle cerebral artery	Reference	
Anterior communicating artery	2.02 (1.13–3.58)	0.02
Internal carotid artery	0.43 (0.18–1.01)	0.05
Internal carotid–posterior communicating artery	1.90 (1.12–3.21)	0.02
Basilar tip and basilar–superior cerebellar artery	1.49 (0.78–2.83)	0.23
Vertebral artery–posterior inferior cerebellar artery and vertebrobasilar junction	0.68 (0.16–2.87)	0.60
Other	1.48 (0.61–3.60)	0.39

## Size and Location of Ruptured Intracranial Aneurysms: A 5-Year Clinical Survey

Jens J. Froelich<sup>1</sup>, Sam Neilson<sup>2</sup>, Jens Peters-Wilke<sup>2</sup>, Arvind Dubey<sup>2</sup>, Nova Thani<sup>2</sup>, Albert Erasmus<sup>2</sup>, Michael W. Carr<sup>1</sup>, Andrew W.M. Hunn<sup>2</sup>



**Figure 2.** Frequency of maximum ruptured intracranial aneurysm diameters according to the 4 size groups. 64 (49%) of aneurysms were ≤5 mm (Group A), 31 (24%) were >5–7 mm (Group B), 22 (17%) were >7–10 mm (Group C), and 14 (10%) were larger than 10 mm (Group D).

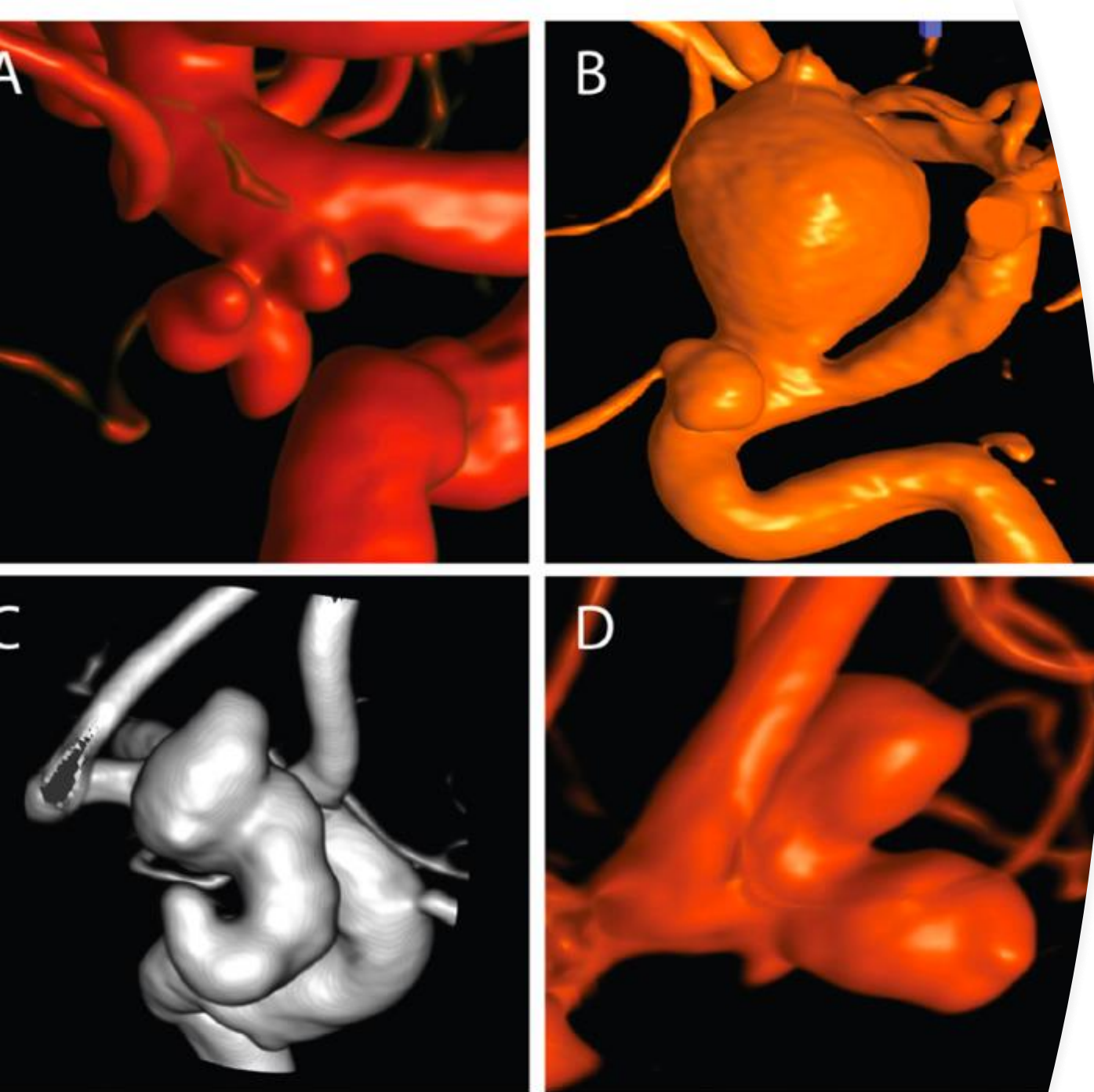
# Risk factors for aneurysm rupture

- Cigarette smoking, 2x
- Prior rupture from another aneurysm, 1.5x
- Family history of rupture, 2 or more 1<sup>st</sup> degree relatives, 17x
- Aneurysm growth, 12x
- Irregular aneurysm shape, 1.6x
- Daughter sac on aneurysm, 7x

# Aneurysm growth

In a pooled analysis of 10 international cohorts of radiologically followed UIA patients, UIA growth was seen in 17% of the followed 1507 patients and in 14% of the 1909 aneurysms during 5782 patient-years of follow-up.<sup>44</sup>

- a) The 3-year growth risk ranged from 5% to 42% and the 5-year growth risk from 9% to 60%, depending on the risk factor status.<sup>43</sup>
- b) The absolute risk of rupture of an aneurysm with detected growth from a total of 312 patients with 329 growing aneurysms. During the 864 aneurysm-years of follow-up, 25 (7.6%) of the aneurysms ruptured in 24 patients. The absolute risk of rupture after growth was 2.9% (95% CI 0.9–4.9) at 6 months, 4.3% (95% CI 1.9–6.7) at 1 year and 6.0% (95% CI 2.9–9.1) at 2 years.<sup>2</sup>
- c) In the triple-S (size, site, shape) prediction model, the 1-year risk of aneurysm rupture after growth ranged from 2.1% to 10.6%.



The most difficult decision making by far is based “aneurysm growth”

- It is extremely difficult monitoring aneurysm size changes by 2D measurements.
- **3D Volumetric comparison** is much more sensitive. However, it is quite a challenge with manual calculation.



# One of the most important and provocative developments in 2023

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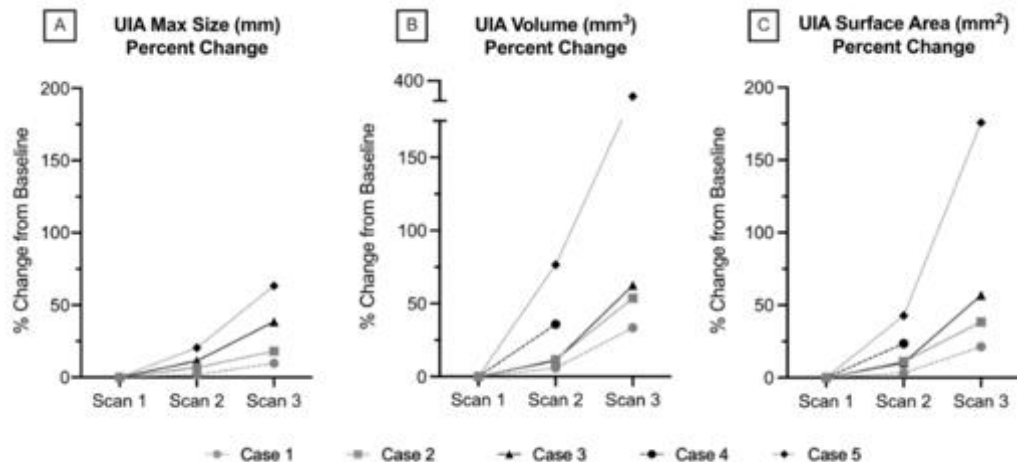
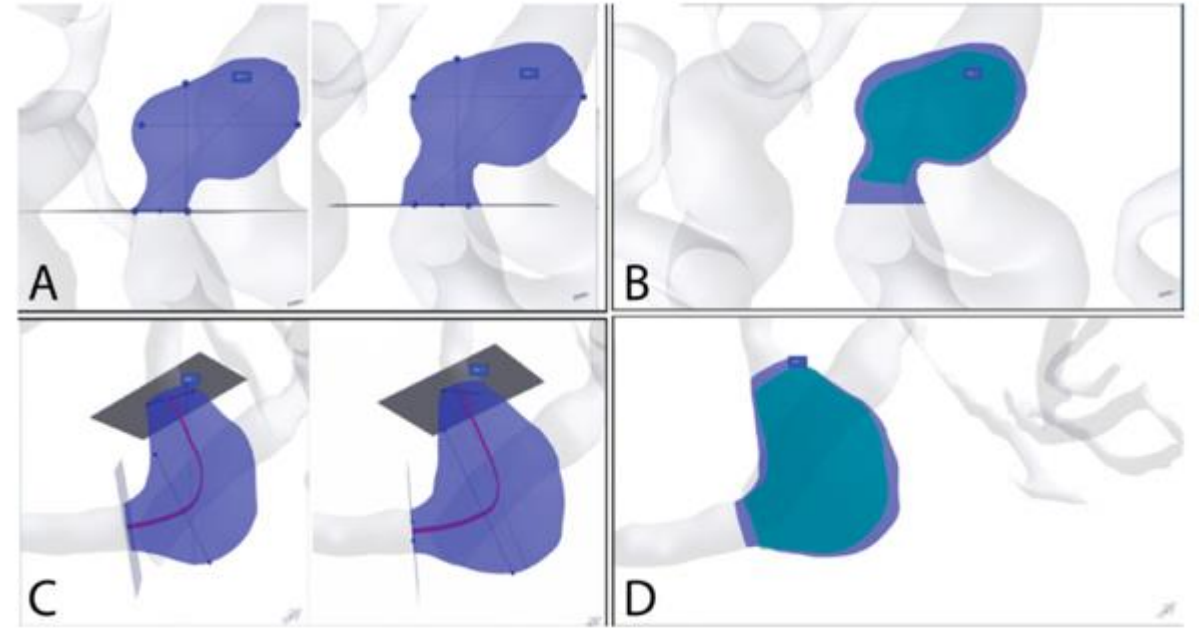
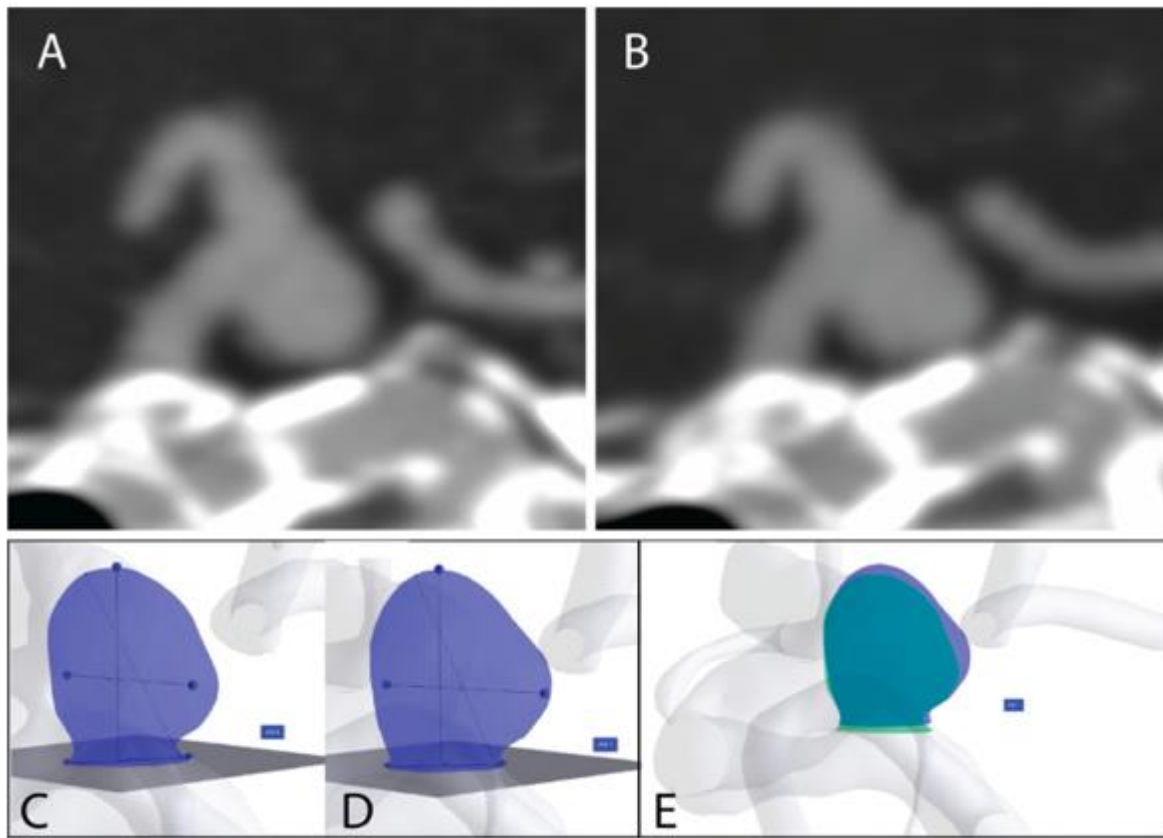
- Monitoring aneurysm size changes with artificial intelligence (AI) based volumetric comparison of aneurysms on CTA over the time.
  - Much more sensitive

Original research

**Artificial intelligence aneurysm measurement tool finds growth in all aneurysms that ruptured during conservative management**

Daniel H Sahlein,<sup>1</sup> Daniel Gibson,<sup>2</sup> John A Scott,<sup>1</sup> Andrew DeNardo,<sup>1</sup> Krishna Amuluru,<sup>1</sup> Troy Payner,<sup>3</sup> David Rosenbaum-Halevi,<sup>1</sup> Charles Kulwin<sup>3</sup>





- Using RAPID Aneurysm Software to achieve aneurysm volumetric comparison during their observation periods.

# In summary

- Technologies in treatment of brain aneurysms have advanced dramatically, that enable us to obliterate aneurysms with a long list of procedure options.
- However, balance of the treatment risk and natural history of unruptured aneurysms must be the key for decision making.
- Among many risk factors for aneurysm rupture, utilize AI for volumetric monitoring of the aneurysm growth is likely a game changer in the decision making of unruptured aneurysm treatment prior to aneurysm rupture.

Thank you