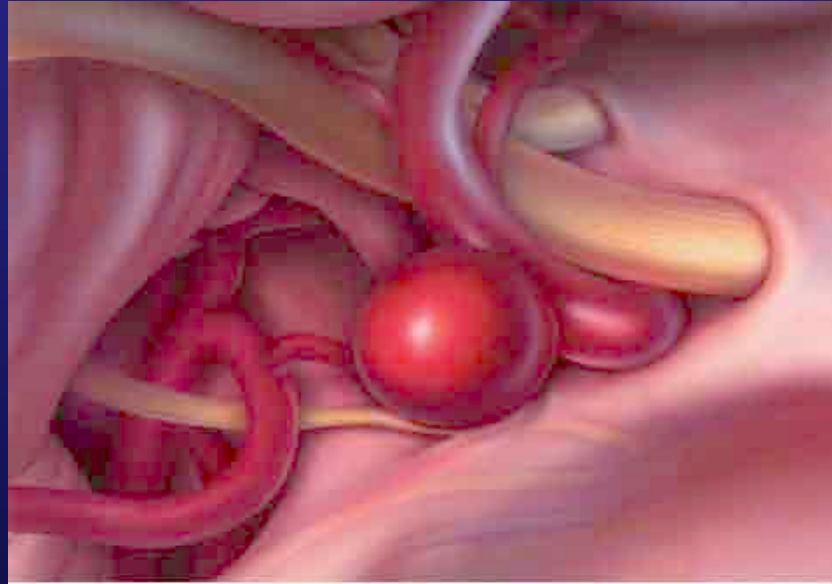


# Unruptured Intracranial Aneurysms: Who and How to Treat



**Robert E. Harbaugh, MD, FACS, FAHA**

**Director, Penn State Institute of the Neurosciences**

**University Distinguished Professor and Chair, Department of Neurosurgery**

**Professor, Department of Engineering Science and Mechanics**

**Penn State University**

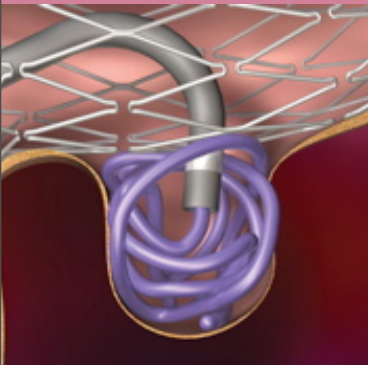
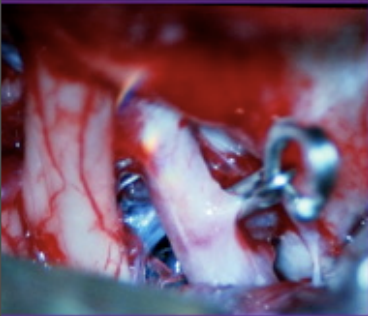


# February 8, 2002

Healthy 74 year old woman with long history of headaches

MRI revealed right frontal cavernous angioma

Angiogram obtained by referring neurologist



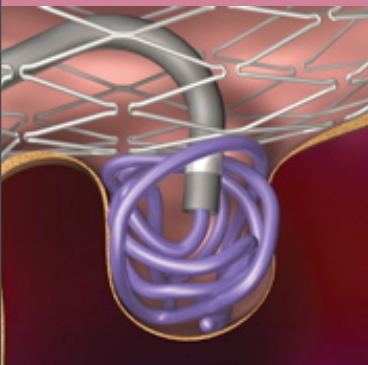
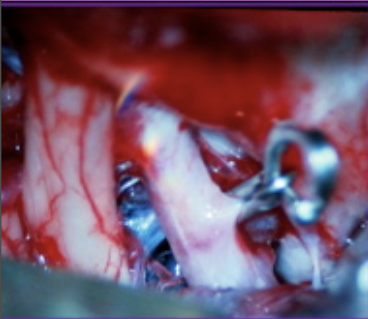


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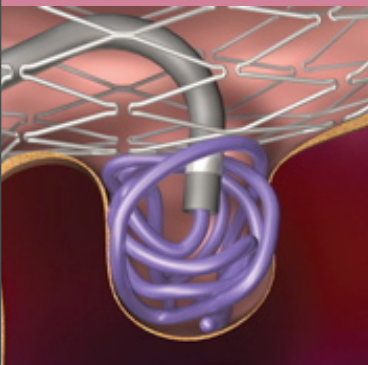
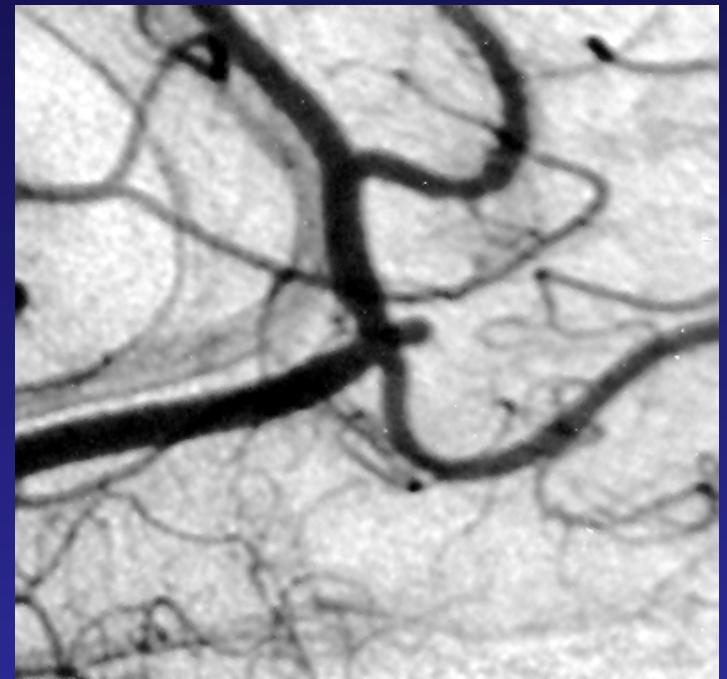
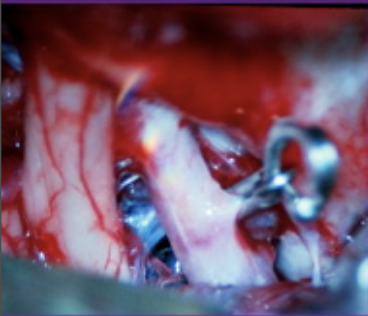
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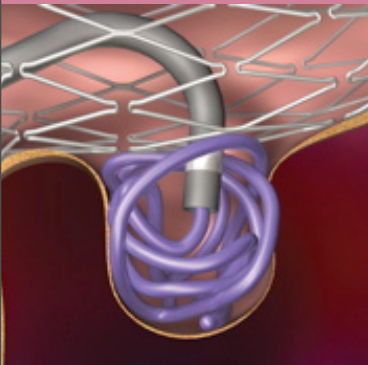






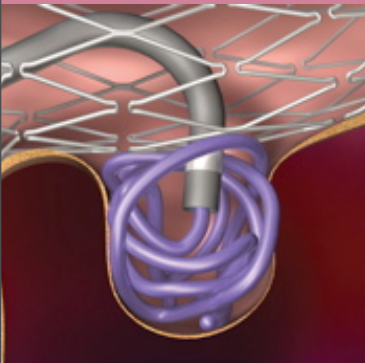
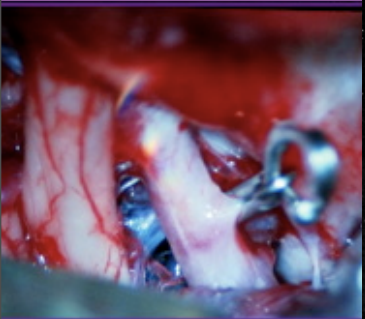
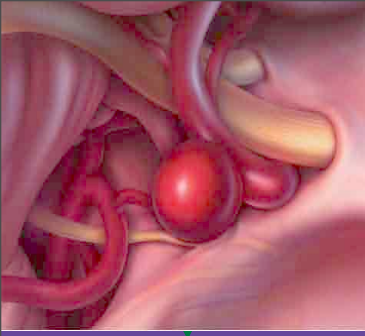
March 4, 2002

Admitted to local hospital with sudden LOC while driving



March 4, 2002

Admitted to local hospital with sudden LOC while driving





# MISTAKES

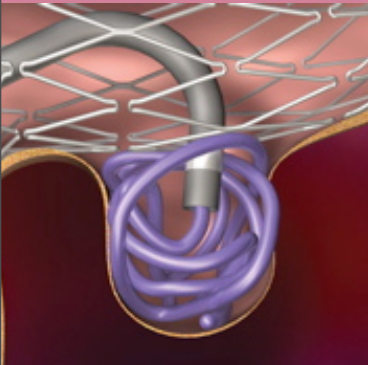
IT COULD BE THAT THE PURPOSE OF YOUR LIFE IS  
ONLY TO SERVE AS A WARNING TO OTHERS.



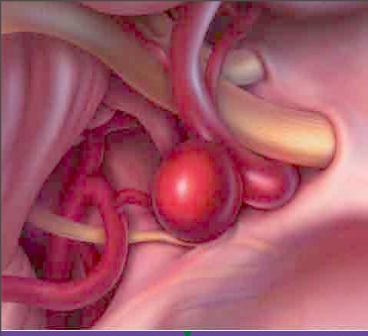
# Should *This* Patient Be Treated? If So, How?



## ➤ Factors considered

- Rupture rate of *this* aneurysm if untreated
  - *This* patient's life expectancy and co-morbidities
  - Morbidity and mortality of rupture in *this* patient
  - Morbidity and mortality of treatment in *this* patient in *my* hands
  - Efficacy of treatment in *this* patient in *my* hands
- 





# Who to Treat: Aneurysm Size and Risk of Rupture

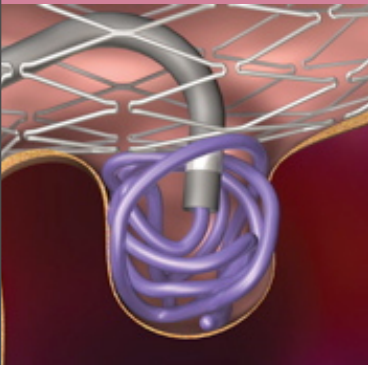
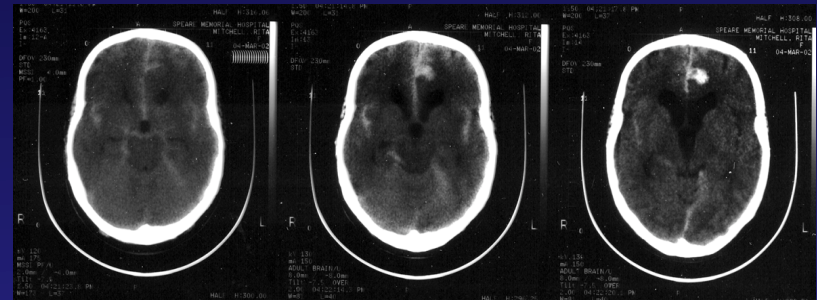
## ISUIA

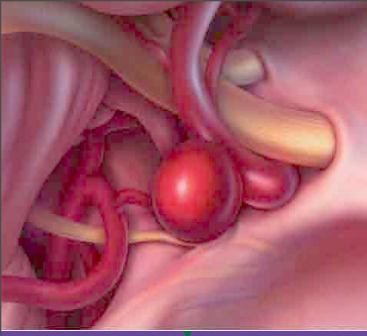
Aneurysms <10 mm  
rarely rupture



## Clinical series

Most ruptured aneurysms  
are <10mm

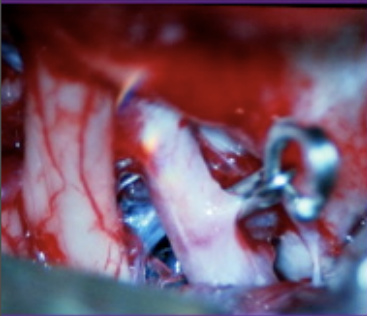




# Who to Treat: Aneurysm Size and Risk of Rupture

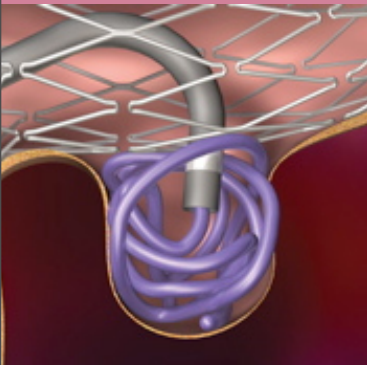
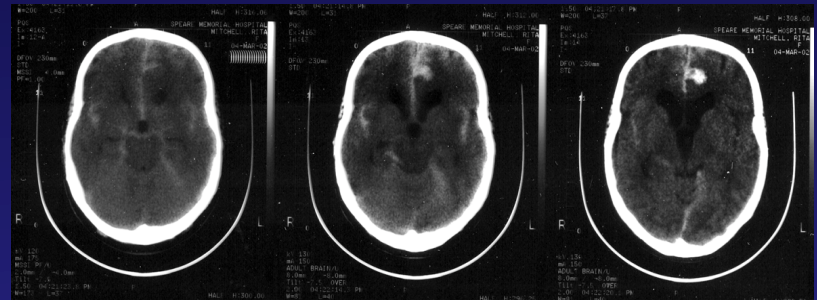
## ISUIA

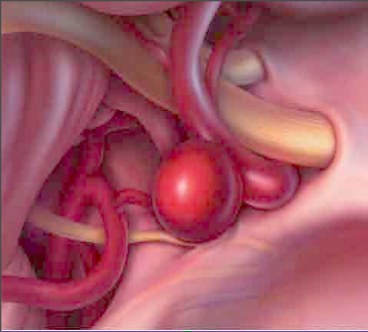
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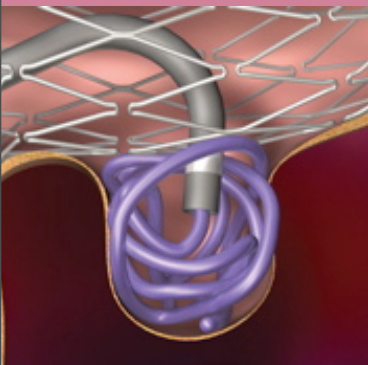




# ISUIA

## Aneurysm Size and Annual Rupture Rates

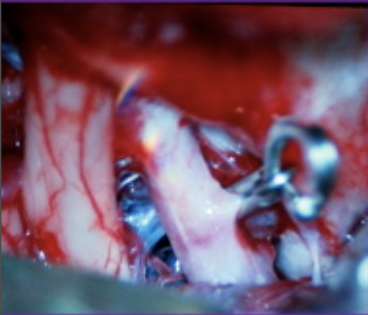
Aneurysm Size	Group 1 (No SAH)	Group 2 (Previous SAH)
2-6 mm	~0.1% 1/1000/year	~0.5% 1/200/year
7-9 mm	~0.5% 1/200/year	~0.5% 1/200/year
10-24 mm	7% in year #1, then 1%/year	1.0% 1/100/year
25+ mm	17% in year #1, then 2%/year	No data



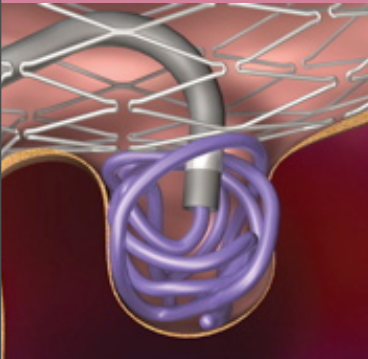


# ISUIA

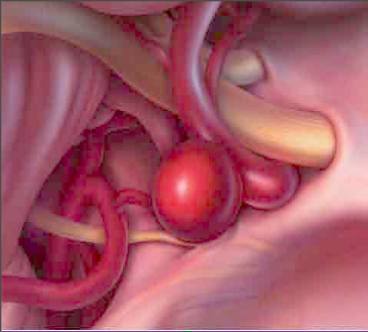
## Aneurysm Size and Risk of Rupture Multivariate Analysis - Combined Cohort



Size vs 2-6 mm	RR	P Value
7-9 mm	2.0	0.073
10-15 mm	5.9	<0.0001
16-24 mm	9.7	<0.0001
25+ mm	27.6	<0.0001





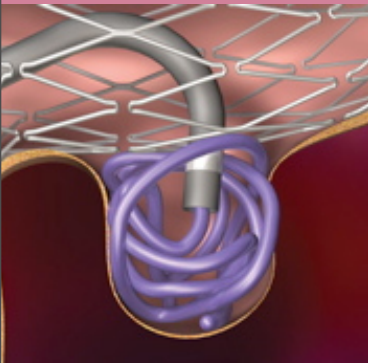


# ISUIA

## Aneurysm Location and Risk of Rupture Multivariate Analysis - Combined Cohort

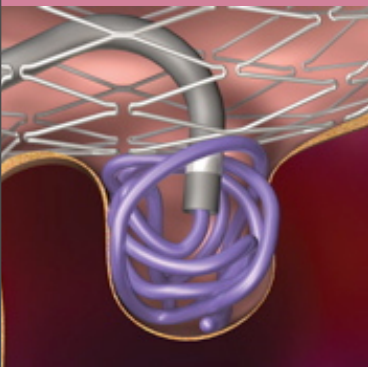
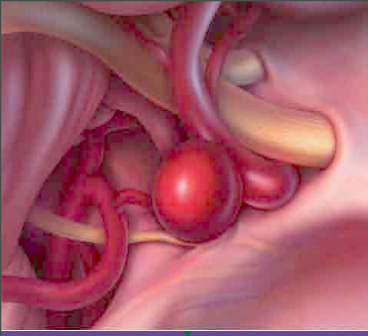


Site vs ICA	RR	P Value
Cavernous	0.2	0.01
MCA	2.2	0.001
PCoA	3.2	0.001
Vertebrobasilar	2.8	0.02
Basilar Apex	3.9	0.0002



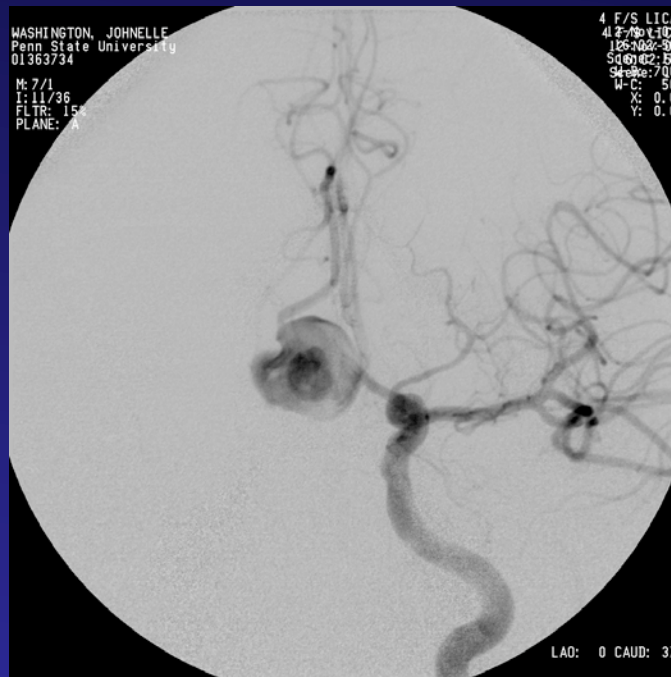
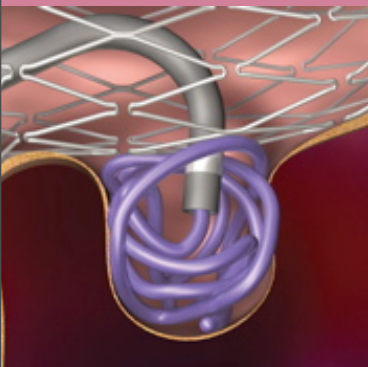
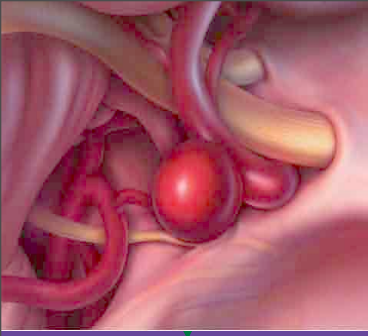
# Who to Treat: What We Need

- Better predictors of aneurysm rupture



# Aneurysm Shape and Risk of Rupture

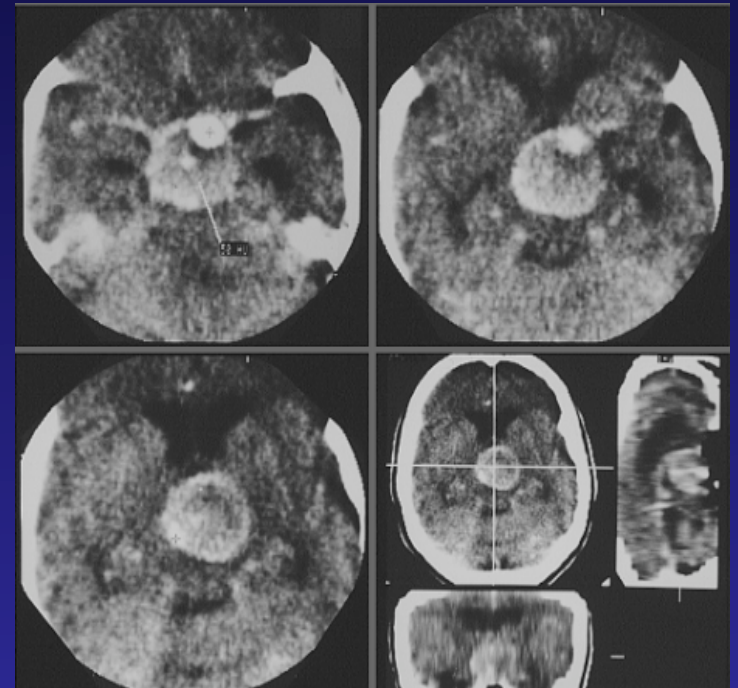
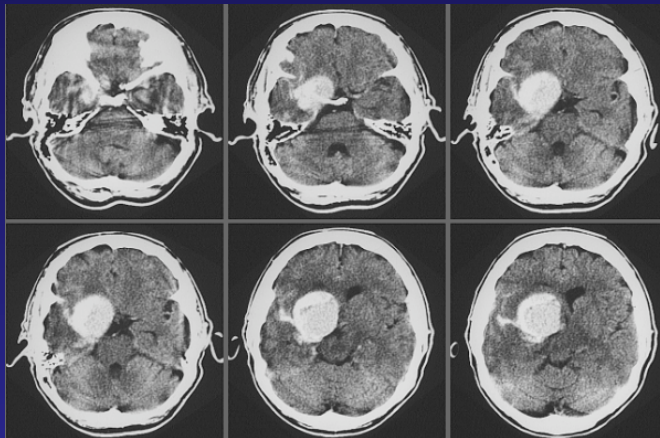
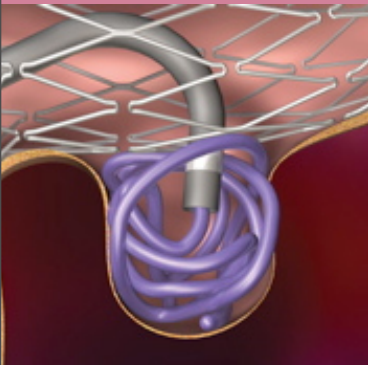
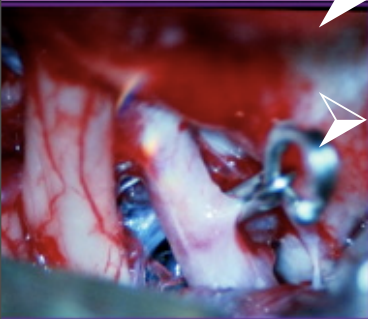
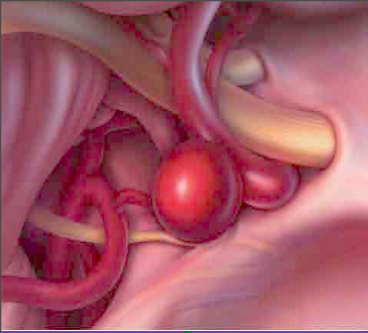
- Is aneurysm shape a predictor of rupture?
- Can we quantify this variable?





# Quantifying Aneurysm Size - Easy

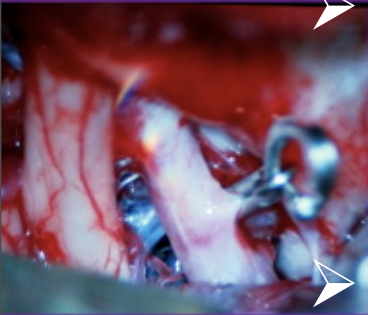
- Greatest dimension
- Surface area
- Volume







# Quantifying Aneurysm Shape - Hard

- 
- Shape is inherently qualitative and more difficult to quantify
  - For use as a predictor of rupture we needed to develop indices that quantify the irregularity of the aneurysm
  - Please refer to accompanying presentation entitled:

*Predicting Aneurysm Rupture: Computer Modeling of Geometry and Hemodynamics*

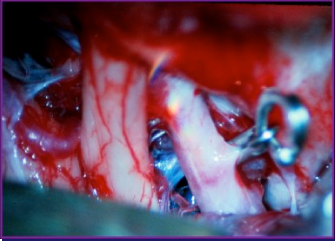



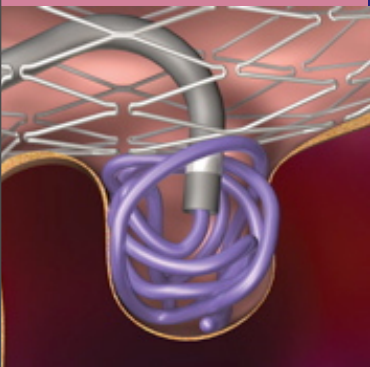
for information on aneurysm shape and risk of rupture

# How to Treat UIAs:

## ISUIA Treatment Outcomes

### Outcomes at One Year After Treatment

 	Clipping		Coiling	
	Group 1 N=1591	Group 2 N=326	Group 1 N=409	Group 2 N=42
Death	2.7%	0.6%	3.4%	0
Rankin 3-5 only	1.4%	0.9%	1%	0
Impaired cognition only	5.5%	7.1%	3.2%	7.1%
Both	3.0%	1.5%	2.2%	0
<b>Total</b>	<b>12.6%</b>	<b>10.1%</b>	<b>9.8%</b>	<b>7.1%</b>



# How to Treat UIAs: ISUIA Treatment Outcomes

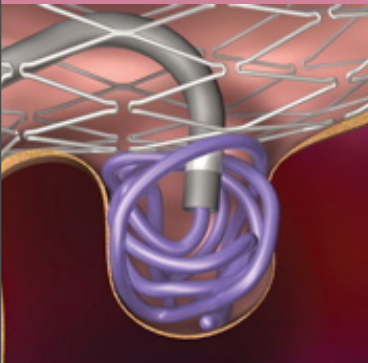
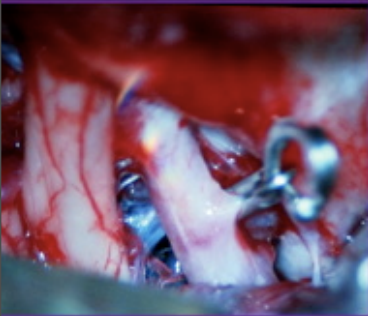
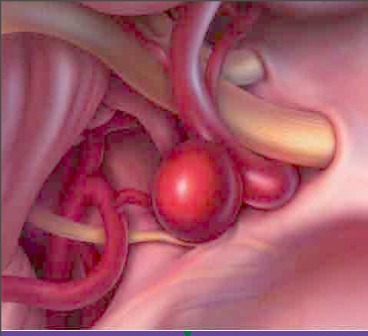
## Surgical Risk Factors

Diameter >25 mm  
RR 3.7

Age >50 years  
RR 2.5

Symptomatic  
Aneurysm RR 1.8

Posterior Circulation  
RR 1.6



# How to Treat UIAs: ISUIA Treatment Outcomes

## Aneurysm Obliteration with Coiling

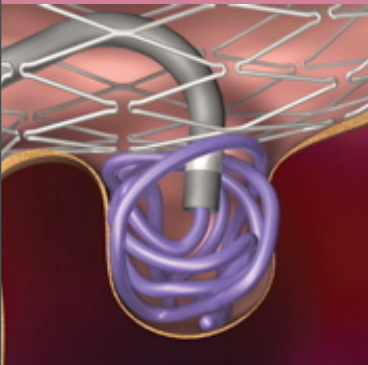
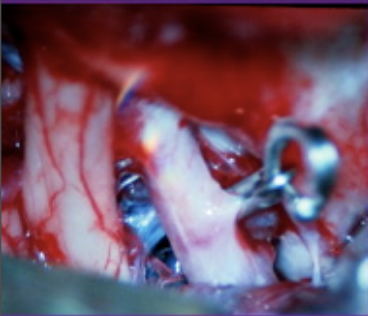
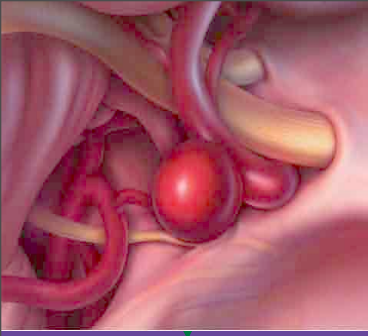
55% complete

24% partial

18% unobliterated

3% unknown

Efficacy?







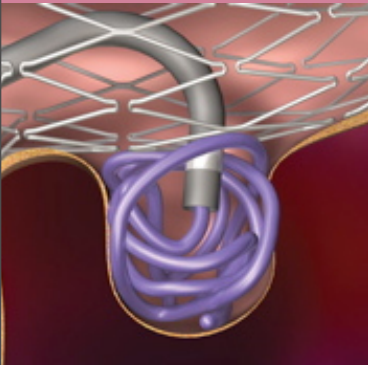
# How to Treat UIAs: ISUIA Conclusions



M&M in surgical patients ~3% higher than in endovascular patients at one year

55% of endovascularly treated aneurysms achieved complete obliteration

Surgical M&M higher in older patients with large and/or posterior circulation aneurysms



Preferred therapy over the life of the patient remains undetermined - particularly for younger patients with anterior circulation aneurysms



# How to Treat UIAs

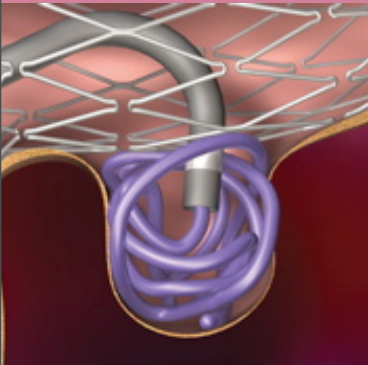


- Factors to be considered

- Efficacy of treatments

- Morbidity and mortality of treatments

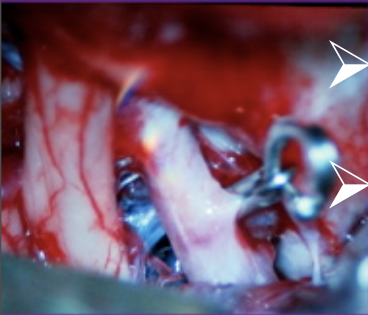
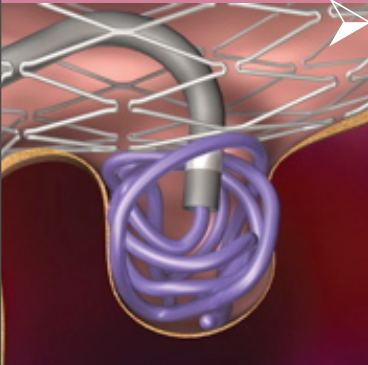
- Morbidity and mortality of rupture



- Decision analysis methodology may be helpful in clarifying our thinking


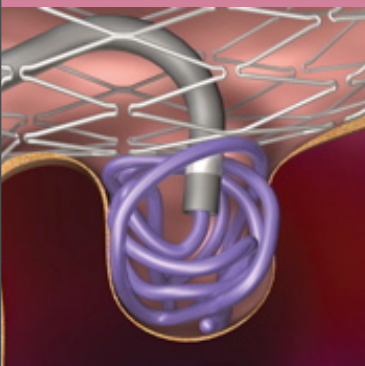


# Decision Analysis Methodology

- Construct a quantified decision tree (Markov Model)
  - Patient cohort progresses through the model
  - Patients exposed to quantified risks of treatment/lesion
  - Patients exposed to actuarial risks
  - Determines cohort that acquires the most benefit in quality adjusted life years (QALYs)
- 
- 



# Assumptions for Our Model

- 
- **Baseline Case: Clip, Coil or Observation?**
    - Patients start out neurologically well at age 40
    - Patients are candidates for all treatments
    - Natural history annual rupture rate is 1.46%
    - Clipping has 11.2% morbidity/mortality, decreases risk of hemorrhage by 95% and has a disutility of 3 months
    - Coiling has 5.6% morbidity/mortality, decreases risk of hemorrhage by 75% and has a disutility of 6 weeks
    - % achieving each GOS score derived from literature
    - Actuarial risks from 1998 U.S. Health Statistics
    - Standard discount rate for later years of life
- 

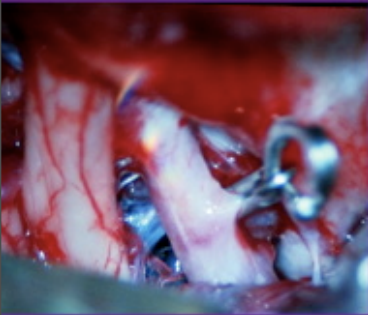




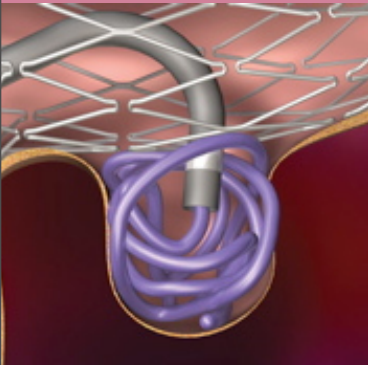
# Utilities

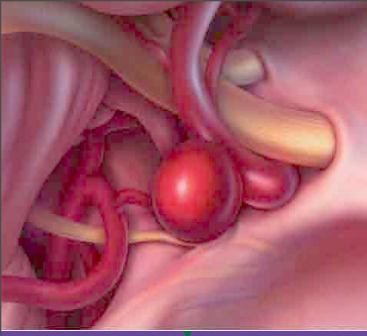
Standard gamble methodology using a medically sophisticated,  
risk-averse population

From Aoki et al., Med. Dec. Making, 1998



Glasgow Outcome Scale Score	Utility
1 (Dead)	0
2 (Vegetative)	0.08
3 (Severe disability)	0.26
4 (Moderate disability)	0.63
5 (Back to work/minor deficit)	0.85
6A (No deficit/with aneurysm)	0.95
6B (No deficit/without aneurysm)	1.00



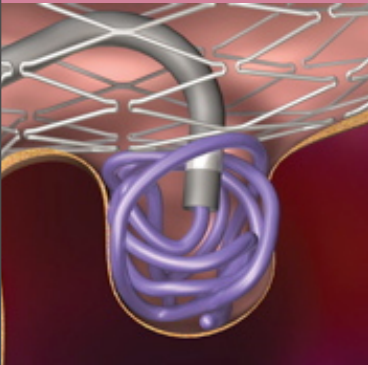
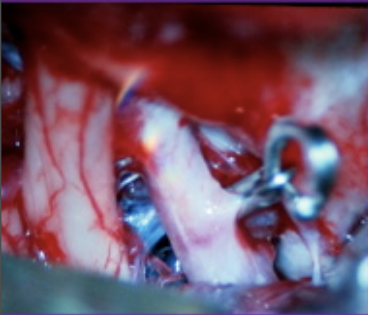
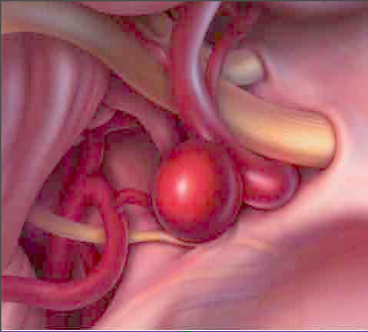


# Markov Model

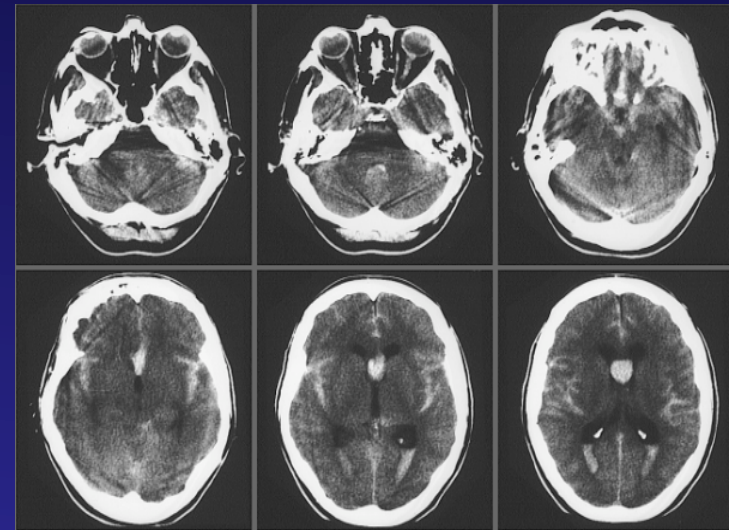
DATA (Decision Analysis by TreeAge) software



# Effect of Duration of Study

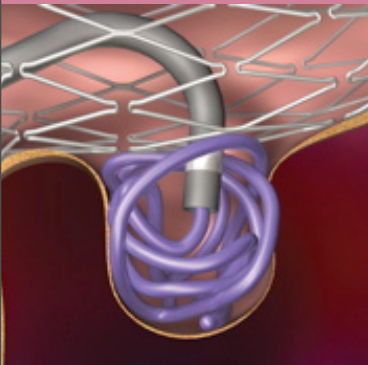
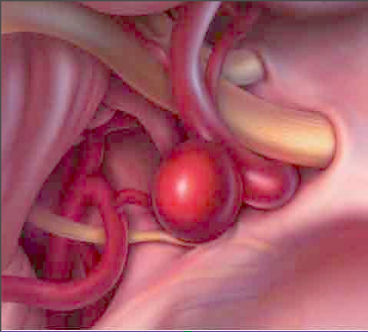


One year from entry  
Observation - 0.93 QALY  
Coiling - 0.87 QALY  
Clipping - 0.75 QALY

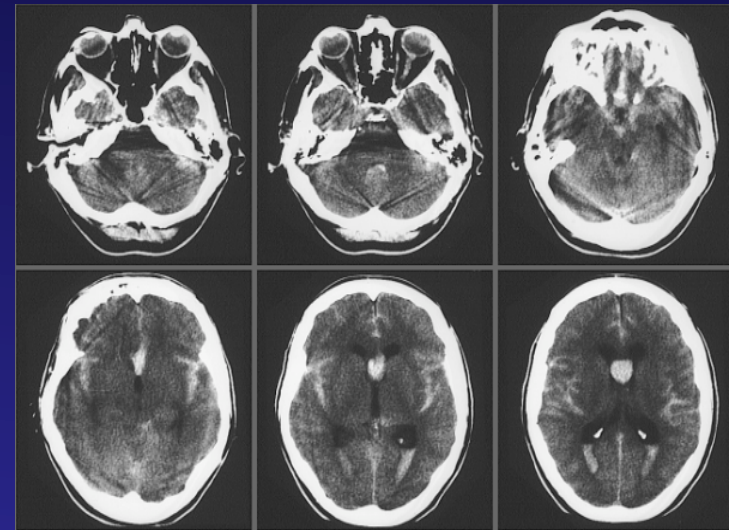




# Effect of Duration of Study



Five years from entry



One year from entry

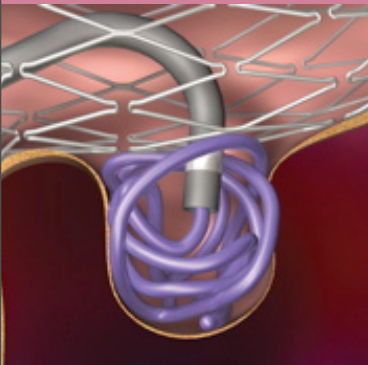
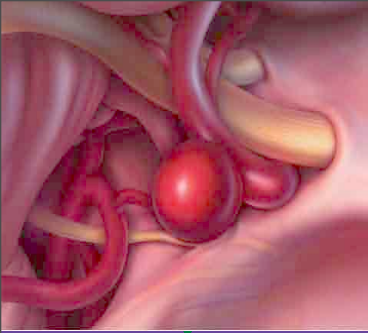
Observation - 0.93 QALY

Coiling - 0.87 QALY

Clipping - 0.75 QALY

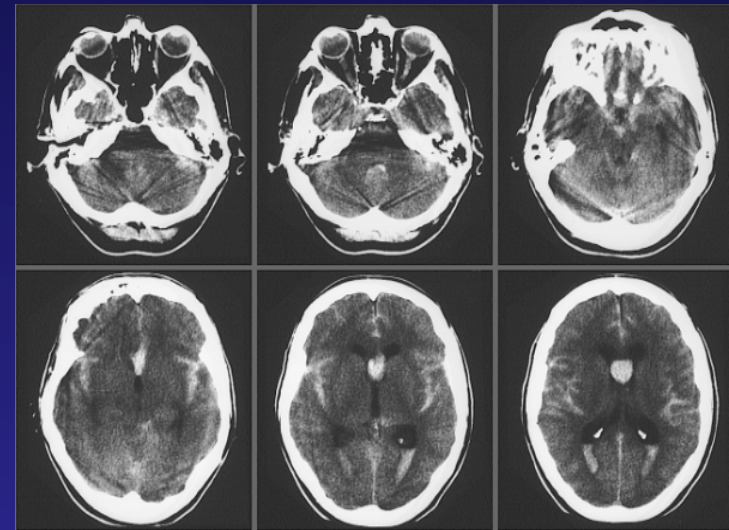


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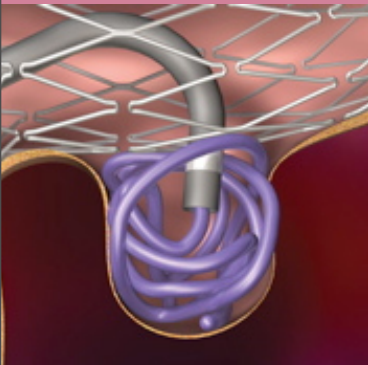
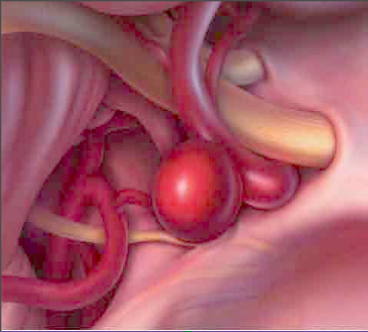


Five years from entry  
Coiling - 4.77 QALY

One year from entry  
Observation - 0.93 QALY  
Coiling - 0.87 QALY  
Clipping - 0.75 QALY

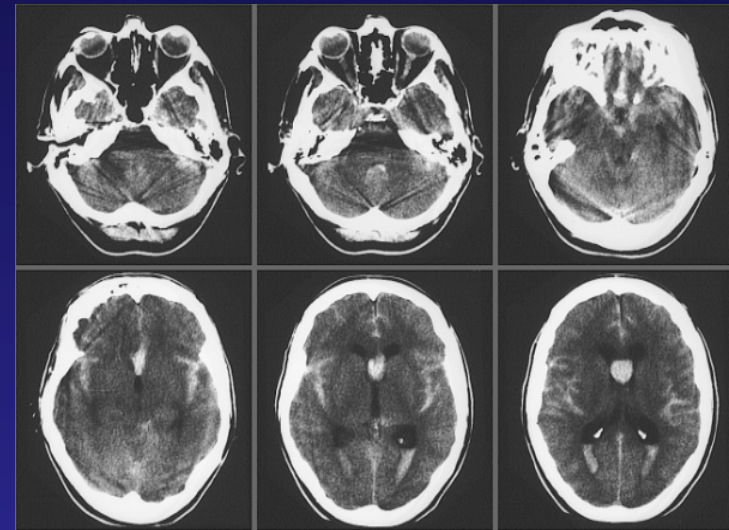


# Effect of Duration of Study



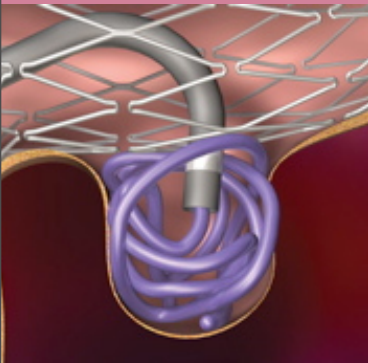
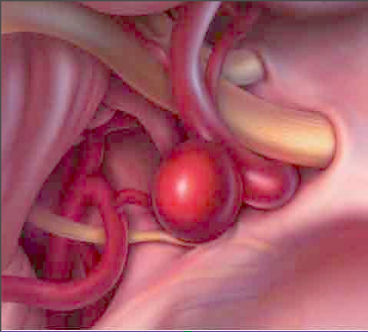
Five years from entry  
Coiling - 4.77 QALY  
Clipping - 4.72 QALY

One year from entry  
Observation - 0.93 QALY  
Coiling - 0.87 QALY  
Clipping - 0.75 QALY



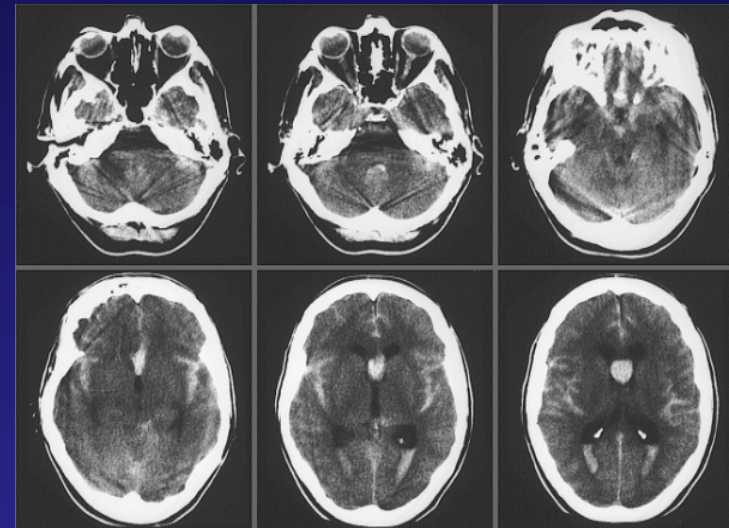


# Effect of Duration of Study



Five years from entry  
Coiling - 4.77 QALY  
Clipping - 4.72 QALY  
Observation - 4.52 QALY

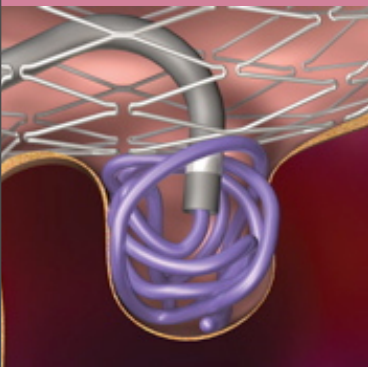
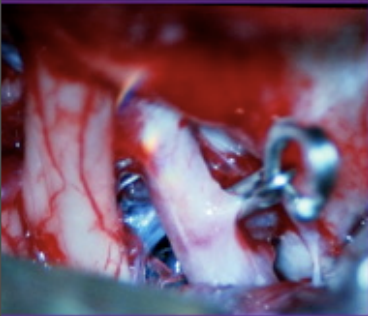
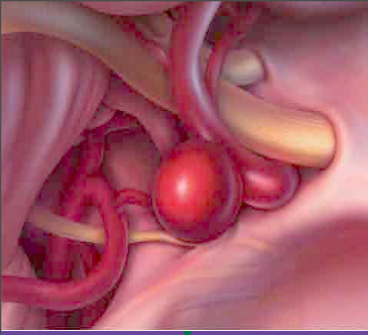
One year from entry  
Observation - 0.93 QALY  
Coiling - 0.87 QALY  
Clipping - 0.75 QALY



# Results of Decision Analysis

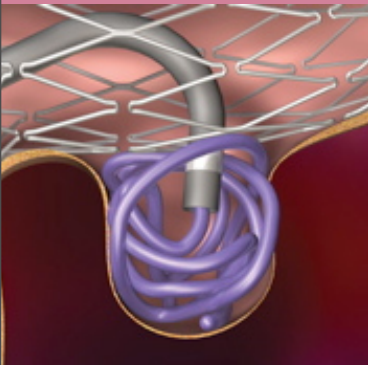
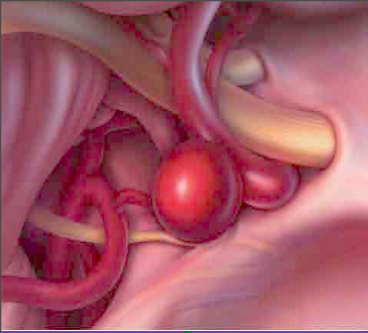
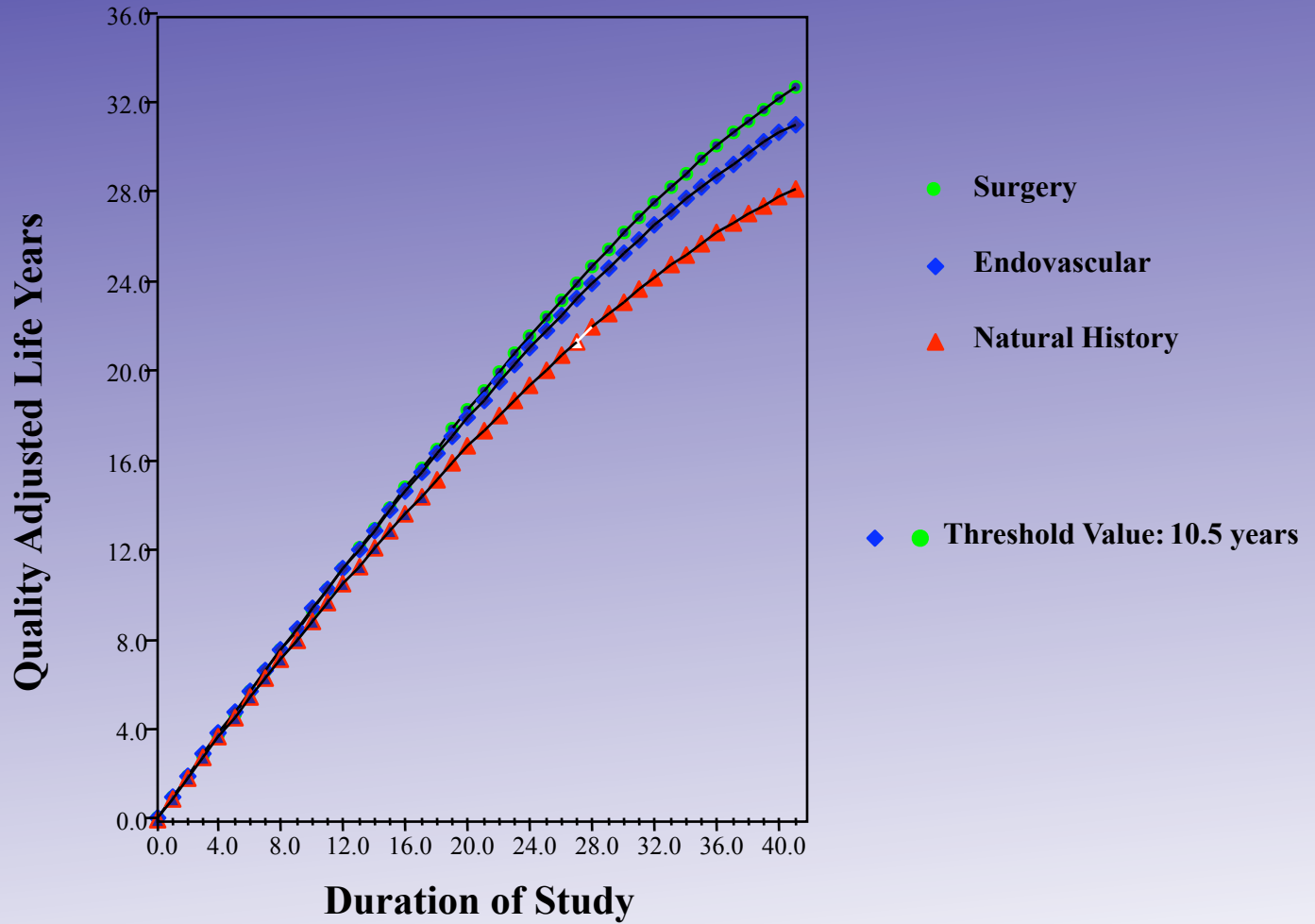
## ➤ Lifetime

- Clipping - 32.17 QALY
- Coiling - 30.62 QALY
- Observation - 27.75 QALY



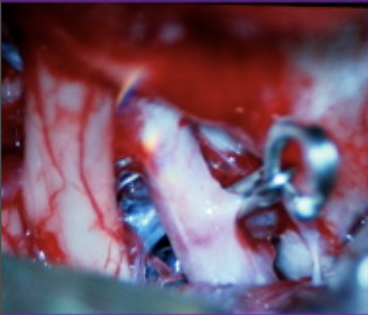


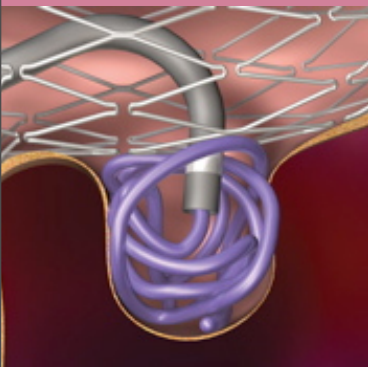
# Sensitivity Analysis: Duration of Study





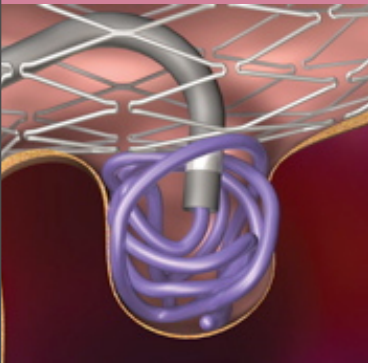
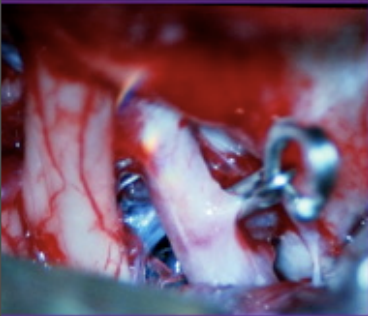
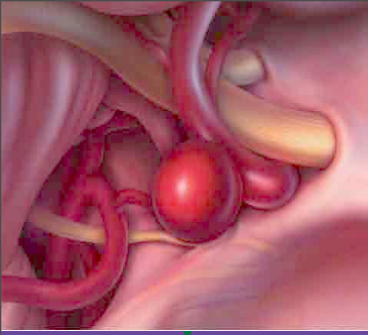
## What We Need

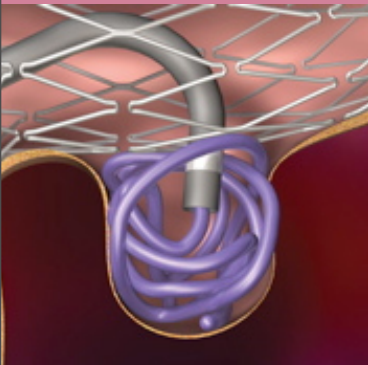
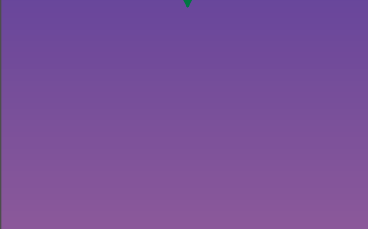
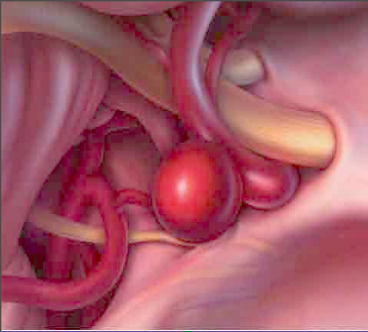
- 
- Better understanding of the effectiveness and morbidity of endovascular and microsurgical treatments
  - Long term studies are needed. Short term studies may generate misleading data.



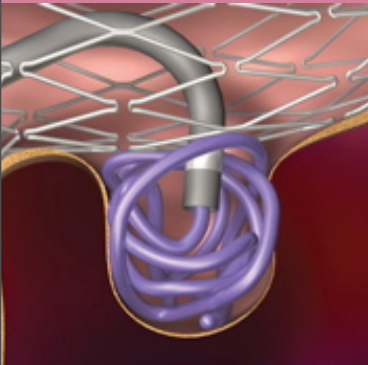
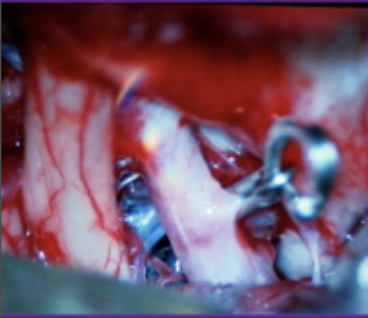
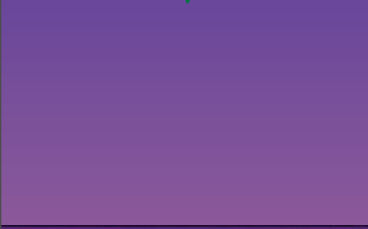
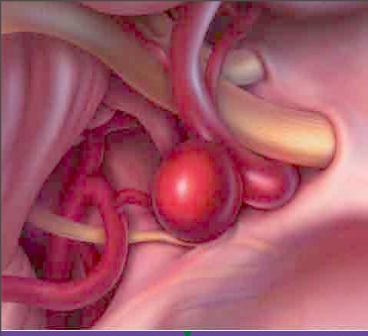
March 19, 2002

Discharged home









Thank You