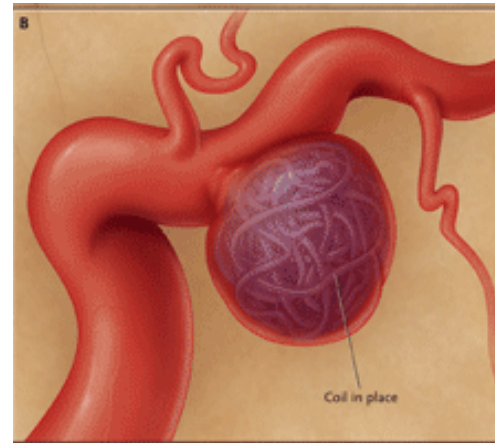
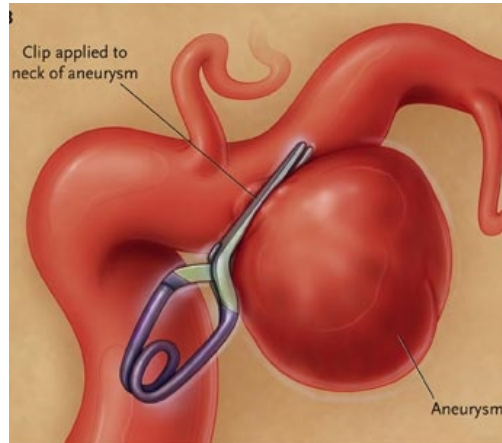


ANEURYSM SURGERY-COMPARISON WITH COILING AND FUTURE



Introduction

- Cerebral aneurysms : a formidable challenge for neurosurgeons and interventional neuroradiologists.
- Presentation
 - 1) Mass effect- cranial nerve palsies
 - 2) Rupture- hemorrhage

Introduction

- Intracranial aneurysms are common
- Overall frequency in general population- 0.2 to 9.9 % (mean- 5%)
- Incidence of aneurysmal SAH - approximately 10 cases per 100,000 persons per year

International Study of Unruptured Intracranial Aneurysms Investigators.
Unruptured intracranial aneurysms—risk of rupture and risks of surgical
intervention. N Engl J Med 1998;339:1725–33.

- Rupture rare, but when it occurs results are catastrophic
 - Six months' mortality- more than 50%
 - 15% die before reaching the hospital
 - 40% within 24 hours

Hop JW, Rinkel GJ, Algra A, et al. Case-fatality rates and functional outcome after subarachnoid hemorrhage: a systematic review. *Stroke* 1997;28: 660–4.

Mayberg MR. A clinical update on the diagnosis and treatment of subarachnoid hemorrhage: focus on medical management. *A CME Clinical Reference Compendium* 2004; January. p. 5–11.

- 1/3 of survivors have functional independent lives
- Rebleeding has a catastrophic morbidity of 48% to 78%

Kassell NF, Torner JC. The International Cooperative Study on Timing of Aneurysm Surgery—an update. *Stroke* 1984;15:566–70.

Locksley HB. Natural history of subarachnoid hemorrhage, intracranial aneurysms and arteriovenous malformations. Based on 6368 cases in the cooperative study. *J Neurosurg* 1966;25:219–39.

Locksley HB. Natural history of subarachnoid hemorrhage, intracranial aneurysms and arteriovenous malformations. *J Neurosurg* 1966;25:321–68.

Suzuki J, Hori S, Sakurai Y. Intracranial aneurysms in the neurosurgical clinics in Japan. *J Neurosurg* 1971;35:34–9.

Treatment options

- Two treatment modalities
- To exclude the aneurysm from the circulation:
 - microsurgical clipping
 - endovascular coiling

Clipping	Coiling
More invasive	Less invasive, needs a groin puncture
Requires craniotomy	Negates the need for craniotomy
Open dissection of the aneurysm followed by clipping	The aneurysm is excluded from within using microcoils

Factors affecting decision

- Safety and efficacy
- Patient's expected longevity
- Ruptured or unruptured
- Aneurysm factors
 - Size
 - Configuration
 - Location
- Operator's experience

Clip vs coil: Safety

- The superiority of either of the treatment options has not been defined
- Each has its own merits and demerits

Clip vs coil: Safety

- Clipping

The mortality rate 1% - 3.8%

The morbidity rate 4% - 12%.

King jt jr, berlin ja, et al. Morbidity and mortality from elective surgery for asymptomatic, unruptured, intracranial aneurysms: a meta-analysis. J neurosurg 1994;81(6):837-42.

- Coiling

The mortality rate 0.5% - 2%

The morbidity rate is 4% to 5%

Johnston SC, Dudley RA, et al. Surgical and endovascular treatment of unruptured cerebral aneurysms at university hospitals. Neurology 1999;52(9): 1799-805.

Clip vs coil: Safety

- The most comprehensive study looking at the risks of surgical treatment was the International Study of Unruptured Intracranial Aneurysms (ISUIA) .
- Prospective study of 961 patients
 - No history of SAH
 - Mortality rate of 2.3% at 30 days and 3.8% at 1 year
 - Morbidity rate of 12% at 1 year

Clip vs coil: Safety

- The safety of endovascular coiling compared with clipping was further augmented by the results of the International Subarachnoid Aneurysm Trial (ISAT).
 - Prospective, randomized, controlled trial
 - Neurosurgical clipping versus endovascular coiling
 - 2143 patients with ruptured intracranial aneurysms
 - An absolute risk reduction of 8.7% at 1 year.

Efficacy: Clip vs coil

- ‘Efficacy’ : an important factor in favor of microsurgical clipping, because clipping seems to be superior to coiling in achieving those goals over short and long term.
- Most series report a 92% to 96% exclusion rate of the aneurysm from the circulation with microsurgical clipping.

David CA, Vishteh AG, et al. Late angiographic follow-up review of surgically treated aneurysms. J Neurosurg 1999;91(3):396–401.

Clip vs coil : Efficacy

- With respect to endovascular coiling, most series report
 - 40% to 55% complete exclusion,
 - 35.4% to 52% near-complete exclusion
 - 3.5% to 8% incomplete exclusion of the aneurysms from the circulation.

Murayama Y, Nien YL, et al. Guglielmi detachable coil embolization of cerebral aneurysms: 11 years' experience. J Neurosurg 2003;98(5):959–66.

Patient factors : Age

- Morbidity and mortality rate in those patients undergoing surgical clipping.
 - 6.5% for patients less than 45 years old
 - 14.4% for patients 45 to 65 years old
 - 32% for patients greater than 64 years old

Investigators I. Unruptured intracranial aneurysms :risk of rupture and risks of surgical intervention. N Engl J Med 1998;339:1725–33.

- Similar finding have been reported with endovascular coiling, but the effects seem to be less significant with endovascular coiling in older patients.

Barker FG II, Amin-Hanjani S, et al. Age-dependent differences in short-term outcome after surgical or endovascular treatment of unruptured intracranial aneurysms in the United States, 1996–2000. Neurosurgery 2004;54(1):18–28 [discussion: 28–30].

Life expectancy

- The patient's life expectancy is related to
 - Age
 - Associated co morbidities
- Life expectancy
 - Long: > 16 years
 - Intermediate: 5 to 15 years
 - Short: < 5 years.

Life expectancy

- Extremely important in unruptured aneurysms as estimated length of life translates into the patient's length of risk from the aneurysm in an untreated (natural history) or treated form.

Neurological grade

- In patients with ruptured aneurysms, the patient's neurologic condition after the initial hemorrhage is directly associated with survival, and therefore longevity.
- WFNS I grade: excellent recovery
- WFNS II and III grade: good recovery
- WFNS IV and V grade: unfavorable outcome is expected in greater than 50% of the patients.

Rosen DS, Macdonald RL. Grading of subarachnoid hemorrhage: modification of the World Federation of Neurosurgical Societies scale on the basis of data for a large series of patients. *Neurosurgery* 2004;54(3):566–75 [discussion: 575–6].

Aneurysm factors : size

- Increased size : increased risk with microsurgical treatment.
- Wirth and colleagues have demonstrated a linear relation with regard to size and outcome, with complication rate
 - 3% for aneurysms less than 5 mm
 - 7% for 6- to 15-mm aneurysms
 - 14% for aneurysms of 16 to 24 mm.

Wirth FP, Laws ER Jr, et al. Surgical treatment of incidental intracranial aneurysms. *Neurosurgery* 1983;12(5):507–11.

Aneurysm factors : size

- Endovascular treatment
 - Extremely large and extremely small aneurysms having increased complications.
- Extremely small aneurysms
 - Risk of intra-procedural rupture .
- Giant aneurysms: less favorable d/n ratio
 - Higher incidence of a branch vessel origin of the aneurysm neck
 - Intra-aneurysmal thrombus.

Aneurysm factors : size

- Surgical clipping is less affected than coiling by increasing size of the aneurysm.
- Increased aneurysm size is associated with significant residual aneurysm
- Large calcified aneurysms may be treated with parent vessel occlusion with an associated cerebral bypass in select cases with effective results

Aneurysm factors : size

- Endovascular coiling is associated with significant aneurysm recanalizing and rebleeding with increasing size of the aneurysm with rates of post procedural hemorrhage of 3.5% per year in UIAs larger than 10 mm in size .

Lanterna LA, Tredici G, et al. Treatment of unruptured cerebral aneurysms by embolization with Guglielmi detachable coils: case-fatality, morbidity, and effectiveness in preventing bleeding systematic review of the literature. *Neurosurgery* 2004; 55(4):767–75 [discussion: 775–8].

Aneurysm configuration

- The most important factor relating to aneurysm configuration is the d/n ratio
- Higher the d/n ratio, better the prognosis

Aneurysm configuration

- Dense packing of the coils within the aneurysmal sac can be achieved with less risk of migration of the coil into the parent artery
 - A small dome size
 - A small neck
 - Large d/n ratio
- These conditions enhance the complete occlusion of the aneurysm with fewer complications

Aneurysm configuration

- Wide-necked aneurysms and aneurysm involving the major neighboring artery(ies)
 - The surgical complexity is increased and experience is required to ensure complete exclusion of the aneurysm with preservation of the parent vessel and its associated branches

Aneurysm location

- Posterior circulation aneurysms:
 - Higher complication rate with microsurgical treatment when compared with anterior circulation aneurysms of similar size

Raaymakers TW, Rinkel GJ, et al. Mortality and morbidity of surgery for unruptured intracranial aneurysms: a meta-analysis. Stroke 1998;29(8): 1531–8.

- Endovascular treatment of posterior circulation aneurysms is safer than clipping

Aneurysm location

- Middle cerebral artery aneurysms:
 - Despite major technical advances in imaging and endovascular treatment of cerebral aneurysms, surgical clipping is still the most safe and efficient treatment

Regli L, Uske A, et al. Endovascular coil placement compared with surgical clipping for the treatment of unruptured middle cerebral artery aneurysms: a consecutive series. J Neurosurg 1999;90(6):1025–30.

Aneurysm location

- MCA aneurysms: often originate from one or both of the branching vessels and often have an associated unfavorable d/n ratio.
 - Unable to be coiled
 - May allow for migration of the coil into the parent vessel or a branch, resulting in a stroke

Aneurysm location

- Acom aneurysms:
 - Often require dissection around hypothalamic perforators
 - Risk of cognitive dysfunction with surgical treatment
- In a recent study, Chan and colleagues reported impaired verbal memory and executive function with clipping compared with coiling.

Aneurysm location

- Paraclinoid aneurysms:
 - microsurgical clipping often requires decompression of the optic nerve to expose the proximal neck
 - Blindness is a concern
- However, in contrast to popular belief, no difference in complications has been documented in paraclinoid aneurysms, with regard to visual loss with coiling versus clipping.

Hoh BL, Carter BS, et al. Results after surgical and endovascular treatment of paraclinoid aneurysms by a combined neurovascular team. *Neurosurgery* 2001;48(1):78–89 [discussion: 89–90].

UNRUPTURED ANEURYSM

Management: UA

- In treating UAs, the risk of hemorrhage can be divided into

Low risk: 0.05% per year or less,

Moderate risk: 0.06% to 2% per year,

High risk: greater than 2% per year.

Management: UA

- Single UA less than 5 mm in size, most surgeons do not treat the aneurysm and observe for growth of the aneurysm
- Exceptions : Patients with multiple aneurysms
 - : Posterior circulation aneurysms
 - : History of a prior SAH
 - : A strong family history

These may have an increased risk of hemorrhage, and the surgeon may consider treating an aneurysm of 4 to 5 mm in size in these situations.

Management: UA

- Aneurysms 6 - 24 mm in size: moderate risk of hemorrhage category.
- Aneurysms that are larger in size, such as giant aneurysms (*25 mm*): high risk hemorrhage category
 - *grave* prognosis with a rupture rate of 6% in the 1st year and 45% within 7.5 years.

Management: UA

- D/N ratio
 - large > intermediate > small
- Patient's estimated life expectancy

Management: UA

- The advantage of clipping
 - Effective in changing the natural history of UA in short and long term
- The disadvantage of clipping
 - Risk of treatment is higher than that of coiling

Management: UA

- The advantage of coiling
 - Less invasive and safer than coiling
- Limitation
 - Lack of durability in changing the natural history compared with clipping.

ANTERIOR CIRCULATION ANEURYSMS

Management: UA

- Anterior circulation aneurysms with a large d/n ratio
 - Endovascular coiling should always be considered as the first line of treatment irrespective of estimated life expectancy
 - Because this treatment provides the patient with relatively effective treatment that is safer than clipping

Management: UA

- Anterior circulation aneurysms with small d/n ratio or patients with a long estimated life expectancy
 - should undergo clipping
- In patients with a long estimated life expectancy and a medium d/n ratio
 - clipping would be most appropriate to provide a more durable treatment

Management: UA

- In patients with an intermediate lifetime risk
 - Either treatment would be appropriate
- Short estimated lifetime risk
 - Coiling would be more appropriate

POSTERIOR CIRCULATION ANEURYSMS

Management: UA

- Posterior circulation aneurysms
 - Large and medium d/n ratios - should undergo endovascular coiling regardless of the estimated life expectancy
 - Because endovascular coiling provides a safer treatment that is relatively effective

Management: UA

- Posterior circulation aneurysms
 - Small or unfavorable d/n ratio: coiling should still be considered in those individuals with a short or intermediate estimated life expectancy because it is still probably safer than microsurgical clipping.

Management: UA

- In some posterior circulation aneurysms
 - with less favorable configurations, where the aneurysm sac involves one of the posterior cerebral branches.
- Clipping may be the only alternative

Management: UA

- Microsurgical clipping should also be performed in those patients with an unfavorable or small d/n ratio with a long estimated life expectancy by an experienced neurovascular neurosurgeon so as to provide the patient with reasonably safe and effective long-term treatment

RUPTURED ANEURYSM

Management: RA

- Ruptured aneurysms: the primary cause of death or disability is related to
 - The effect of the initial rupture
 - Subsequent rebleeding
 - Associated complications
 - Hemorrhage
 - Vasospasm
 - Hydrocephalus

Management: RA

- Preventing rebleeding is crucial to prevent further injury to an already compromised brain.

Management: RA

- In ruptured aneurysms, in addition to evaluating the patient's life expectancy based on the premorbid status, the patient's clinical condition (WFNS grade) after the hemorrhage must be considered because this is directly associated with early survival.

Management: RA

- The author arbitrarily places patients into three groups:
 - Those expected to survive with no or minimal deficits (WFNS I),
 - Those expected to survive with mild to moderate deficits (WFNS II and III),
 - Those not expected to survive and most likely to have deficits (WFNS IV and V).

Clipping or Coiling of Cerebral Aneurysms , Gavin Wayne Britz, MD, MPH, Department of Neurological Surgery and Radiology, Harborview Medical Center, University of Washington,

Management: RA

- In ruptured aneurysms, the effectiveness of treatment is particularly vital, because rebleeding is associated with a worse prognosis.

Management: RA

- Ruptured aneurysm in the anterior circulation
 - Clipping is advocated in those patients with medium or small d/n ratios, except in those patients with a short life expectancy and/or a poor clinical grade after the initial hemorrhage
- Endovascular coiling is reserved for
 - Large d/n ratio in whom complete occlusion can be obtained

Management: RA

- In posterior circulation aneurysms
 - Coiling is still the first choice
 - Microsurgical treatment is advocated
 - An unfavorable d/n ratio
 - A long life expectancy
 - A good clinical grade
 - An option in those with a medium d/n ratio

Special circumstances

- Giant calcified aneurysms
- Large aneurysms with intraluminal thrombus
- Aneurysms in which the vessel is originating from the aneurysm
- Dissecting aneurysms
- Fusiform aneurysms
- Mycotic aneurysms

need to be evaluated differently

Special circumstances

- These aneurysms require clipping with or without bypass or vessel sacrifice surgically or endovascularly if treatment is clinically indicated

ISUIA

(International Study of Unruptured Intracranial Aneurysms)

- Divided into two groups

Group 1: No history of SAH

Group 2: H/o SAH from a different aneurysm that had been successfully repaired

ISUIA: 1998

Retrospective component

- Aneurysms < 10 mm in diameter
 - Group 1- 0.05% per year
 - Group 2- 0.5% per year
- Aneurysms > 10 mm in diameter
 - $< 1\%$ per year in both groups
- Giant aneurysms ≥ 25 mm in group 1
 - 6% in the first year

Prospective component

- Surgery related morbidity and mortality

	30 days	1 year
Group 1	17.5%	15.7%
Group 2	13.6%	13.1%

ISUIA: 2003

- Investigators recorded the natural history in patients who did not have treatment, and determined the morbidity and mortality associated with endovascular or microsurgical repair of unruptured aneurysms.

ISUIA

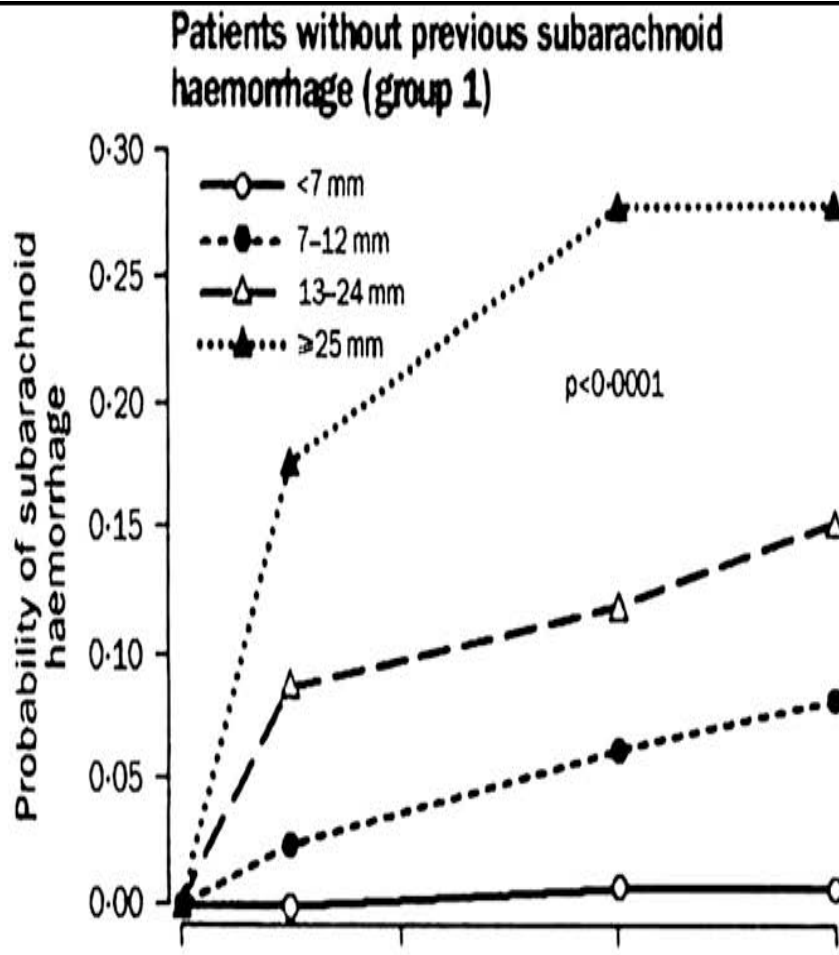
Five-year cumulative rupture rates according to size and location of unruptured aneurysm

	<7 mm		7–12 mm	12–24 mm	> 25 mm
	Group 1	Group 2			
Cavernous carotid artery (n = 210)	0	0	0	3%	6.4%
AC/MC (n = 1037)	0	1.5%	2.6%	14.5	40%
Post P comm (n = 445)	2.5%	3.4%	14.5%	18.4%	50%

Abbreviations: 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.

From Wiebers DO, Whisnant JP, Huston J 3rd, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. *Lancet* 2003;362:103–10; with permission.

ISUIA



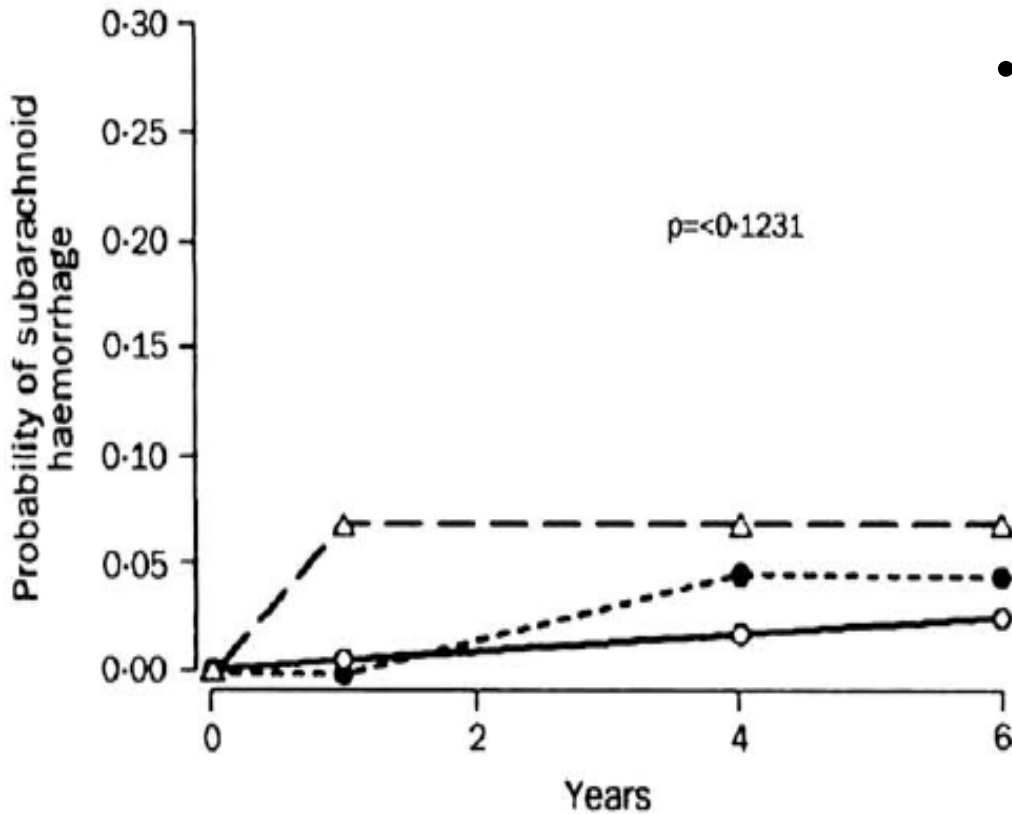
- Probability of subarachnoid hemorrhage over time for patients who did not have surgery.

(From Wiebers DO, Whisnant JP, Huston J 3rd, et al.

Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. *Lancet* 2003;362:103–10)

ISUIA

Patients with previous subarachnoid haemorrhage (group 2)*



Group 2

- Larger aneurysm size was not associated with higher rupture rates in patients who had had a previous aneurysmal SAH (Group 2 patients).

ISUIA

- For both Group 1 and Group 2 patients the combined morbidity and mortality at 1 year was about 3% higher in the microsurgical group (12.6% for clipping vs. 9.8% for coiling in Group 1 patients and 10.1% vs. 7.1% in Group 2 patients).

WAIT AND WATCH ??

- Low rupture rates do not mean no rupture. Aneurysms less than 7 mm can and will rupture, and patients bear the morbidity and mortality of aneurysmal SAH.

WAIT AND WATCH ??

- Furthermore, preliminary neuropsychologic studies demonstrate that patients who harbor and know they have untreated intracranial aneurysms have a reduced quality of life

WAIT AND WATCH ??

- (1) How often should patients be restudied?
- (2) Which modality is best for follow-up (angiography, magnetic resonance angiography, or CT angiography)?
- (3) How much change in an aneurysm should prompt intervention?

WAIT AND WATCH ??

(4) How should patients modify their lifestyle to accommodate an aneurysm?

(5) What are the medicolegal implications of observation?

TO CLIP OR TO COIL

- Two options
 - Endovascular embolization
 - Open surgical clipping
- The goal of either treatment
 - Complete and lasting exclusion of an aneurysm from cerebral circulation
 - With preservation of parent, branching, and perforating arteries

ISAT: One year follow up

- In patients with ruptured intracranial aneurysms suitable for both treatments
 - Endovascular coiling is more likely to result in independent survival at 1 year than neurosurgical clipping
- Dead or dependent at 1 year
 - Endovascular treatment- 23.5%
 - Neurosurgical treatment- 30.9%

ISAT: One year follow up

- The early survival advantage of coiling maintained for upto 7 years
- Patients allocated to endovascular treatment
 - Risk of epilepsy was lower
 - Risk of **late rebleeding was higher**

ISAT: Long follow-up study

- There was an increased risk of recurrent rebleeding from a coiled aneurysm
 - Coiling group- 10 rebleeds
 - Clipping group- 3 rebleeds

ISAT: Long follow-up study

- Death at 5 years
 - 11% in endovascular group
 - 14% in neurosurgical group
 - (p value 0.03)
- Survivors who were independent at 5 years
 - 83% in endovascular group
 - 82% in neurosurgical group
 - (p value not significant)

ISAT: critical appraisal

- Entry criteria to ISAT required subjective agreement that an aneurysm could be treated by either endovascular or open surgery
- Many aneurysms failed to meet that criteria
 - Patients who had life-threatening intra-cerebral or subdural hematomas
 - Incompatible neck-to-dome ratios
 - Parent artery or branch artery incorporation into the dome

ISAT- critical appraisal

- Fusiform aneurysms
- Thrombotic aneurysms
- Blisters
- Pseudo/traumatic aneurysms
- Those with mass effect
- Those that had failed repeated endovascular treatment

ISAT- critical appraisal

- In the ISAT study (selection bias)
 - 9559 patients who had SAH were assessed
 - 7416 were excluded (671 refused and 6,745 for ‘ ‘other reasons’ ’)
 - 2143 were randomized

ISAT- Critical appraisal

- Although published as an international study, 95% of the patients were recruited from Europe
- At best, it may be called a European study.

ISAT- Critical appraisal

- Although it was stated, there was no discrepancy b/w the expertise of interventionist and neurosurgeon
- In fact, **expertise bias**
 - Clipping- under the supervision of general neurosurgeon
 - Coiling- entirely done by an expert interventionist

ISAT- Critical appraisal

Recruitment bias

- Centres with endovascular expertise- most of the patients
- Centres with cerebrovascular surgical expertise- negligible number of patients

Is endovascular treatment flawless??

- New terms, such as
 - (1) greater than 95% occlusion
 - (2) stable residual neck at 2 years
 - (3) protected dome
 - (4) near complete occlusion

now are part of the medical record.

- Surgical management of recurrent partially coiled aneurysms seems technically more difficult and significantly underdeveloped

- Deinsberger W, Mewes H, Traupe H, et al. Surgical management of previously coiled intracranial aneurysms. *Br J Neurosurg* 2003;17:149–54.
- Thornton J, Dovey Z, Alazzaz A, et al. Surgery following endovascular coiling of intracranial aneurysms. *Surg Neurol* 2000;54:352–60.
- Zhang YJ, Barrow DL, Cawley CM, et al. Neurosurgical management of intracranial aneurysms previously treated with endovascular therapy. *Neurosurgery* 2003;52:283–93 [discussion: 293–5].

Facts

- Either clipped or coiled, management of intracranial aneurysms is advantaged in centers where both modalities are available and a volume of SAHs are treated routinely.
- Mortality rates in hospital centers managing fewer than 10 SAH per year were 40% higher than those in high volume centers managing more than 35 SAH per year.

Cross DT 3rd, Tirschwell DL, Clark MA, et al. Mortality rates after subarachnoid hemorrhage: variations according to hospital case volume in 18 states. *J Neurosurg* 2003;99:810–7.

Facts

- The ability to perform intracranial angioplasty had a 16% risk reduction for death.

Johnston SC. Effect of endovascular services and hospital volume on cerebral aneurysm treatment outcomes. *Stroke* 2000;31:111–7.

Facts

- Size (of case load) does matter.
- The California SAH study of 21,540 patients who had SAH and were admitted revealed 40% lower odds of mortality when 21 or more cases per year were managed.

Bardach NS, Zhao S, Gress DR, et al. Association between subarachnoid hemorrhage outcomes and number of cases treated at California hospitals. *Stroke* 2002;33(7):1851–6.

TREATMENT CONSIDERATIONS

- Refer to centers that have interventional and surgical capacities
 - dedicated ICUs
 - intraoperative angiography
 - biplane angiography with 3-D capabilities
 - transcranial Doppler
 - Capabilities to do cerebral blood flow studies

TREATMENT CONSIDERATIONS

- Interventionalists and open surgeons should act as **partners**, not competitors.
- All patients should be assessed clinically and radiologically by both practitioners before a decision for treatment is decided.

TREATMENT CONSIDERATIONS

- The initial angiography is done best by interventionalists with an open surgeon present.

TREATMENT CONSIDERATIONS

- The 3-D reconstruction is invaluable to assess more accurately dome-to-neck ratio and parent artery or branch orientation to neck and enhances surgical view for clip placement and vessel reconstruction

TREATMENT CONSIDERATIONS

- The right of first attempt goes to an interventionalist unless aneurysms are clearly noncoilable like
 - a wide neck
 - Blebs

- Geometrically complex with incorporation of branch artery
- Those with inability to navigate delivery system
- Those that are partially thrombosed
- Fusiform
- Giants

TREATMENT CONSIDERATIONS

- The goal of aneurysm management is complete, durable obliteration without neurologic consequence.
- Surgical clipping surely is a more invasive procedure but also more durable.

TAKE HOME MESSAGE

- Treatment of intracranial aneurysms involves many factors:
 - Patient preference and demographics
 - Aneurysm size, site, geometry, access
 - Practitioner experience and availability
 - Facility; technology; and ancillaries
 - Volume counts
 - Teamwork enhances
 - Management should be individualized

THANK YOU