



# Aneurismi non rotti il parere del neurochirurgo

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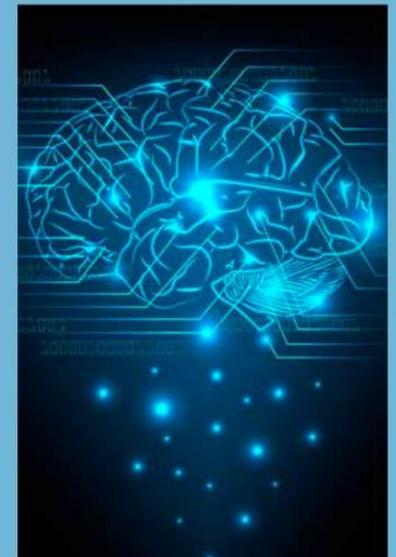
Azienda Ospedaliera Universitaria Integrata

Verona

Traumatologia cranica  
Aneurismi intracranici

**NEURO UPDATE  
TORINO**

9-10 marzo 2017



Torino - 10 marzo 2017

# aneurismi intracranici – key points 1

- prevalenza: 2-3% della popolazione adulta
- solo una minima parte degli aneurismi intracranici va incontro a rottura

## aneurismi intracranici – key points 2

- emorragia subaracnoidea:  
evento potenzialmente catastrofico con mortalità e morbilità molto elevate ( $\cong 35\%$ )
- incidenza SAH: 9/100.000/anno

# aneurismi intracranici – storia naturale

## The New England Journal of Medicine

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NUMBER 24



UNRUPTURED INTRACRANIAL ANEURYSMS — RISK OF RUPTURE AND RISKS  
OF SURGICAL INTERVENTION

THE INTERNAT

ARTICLES

**Unruptured intracranial aneurysms: natural history, clinical  
outcome, and risks of surgical and endovascular treatment**

*International Study of Unruptured Intracranial A*

*The* NEW ENGLAND JOURNAL *of* MEDICINE

ORIGINAL ARTICLE

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

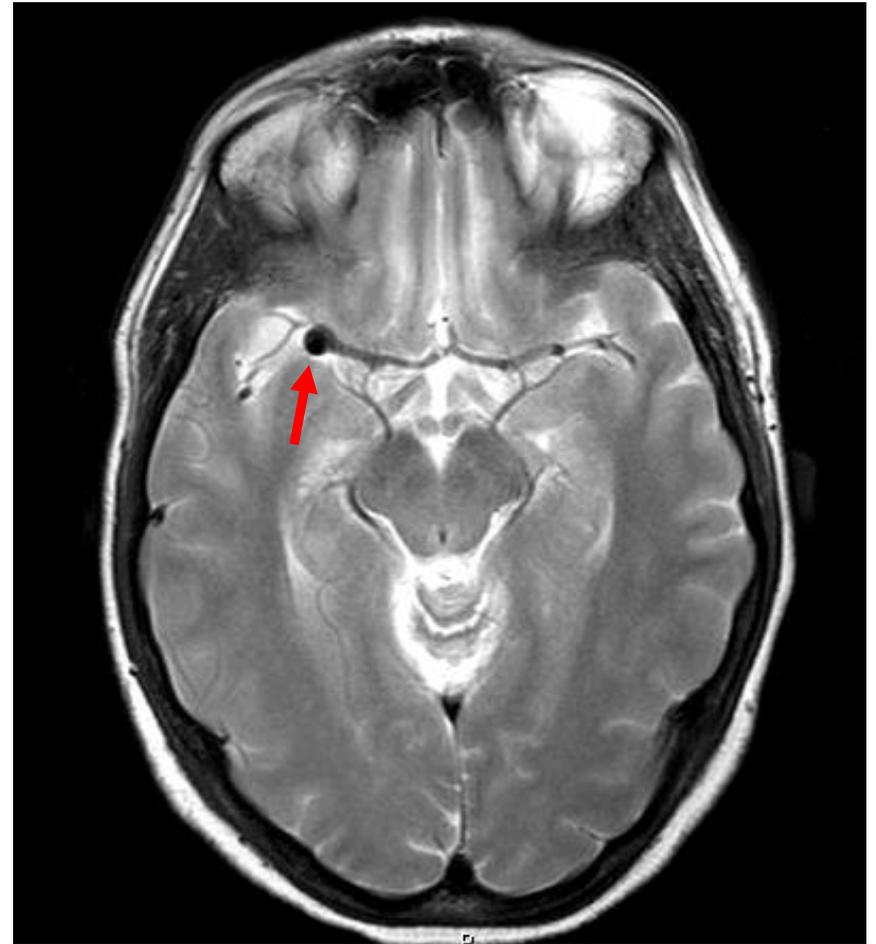
The UCAS Japan Investigators\*

# aneurismi intracranici – storia naturale

- non chiara (problemi metodologici)
- la maggior parte degli aneurismi non si rompe
- principale fattore di rischio di rottura:  
dimensione della sacca
- in buona parte gli aneurismi che si rompono  
sono di piccole dimensioni

# aneurismi intracranici – key points 3

- un numero crescente di persone esegue studi radiologici (CT/MR) per motivi aspecifici
- problema rilevante, risposte difficili



# aneurismi intracranici – key points

- che fare?
- il trattamento preventivo, deciso in modo non sufficientemente critico, comporta rischi rilevanti di complicazioni
- un atteggiamento conservativo, con o senza controlli radiologici, comporta la persistenza di un non elevato ma definito rischio di rottura

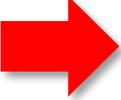
# aneurismi intracranici non rotti

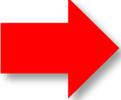
## processo decisionale

- gran mole di dati oggi disponibili
- i dati statistici non sono di alcuna utilità nelle decisioni su un singolo paziente

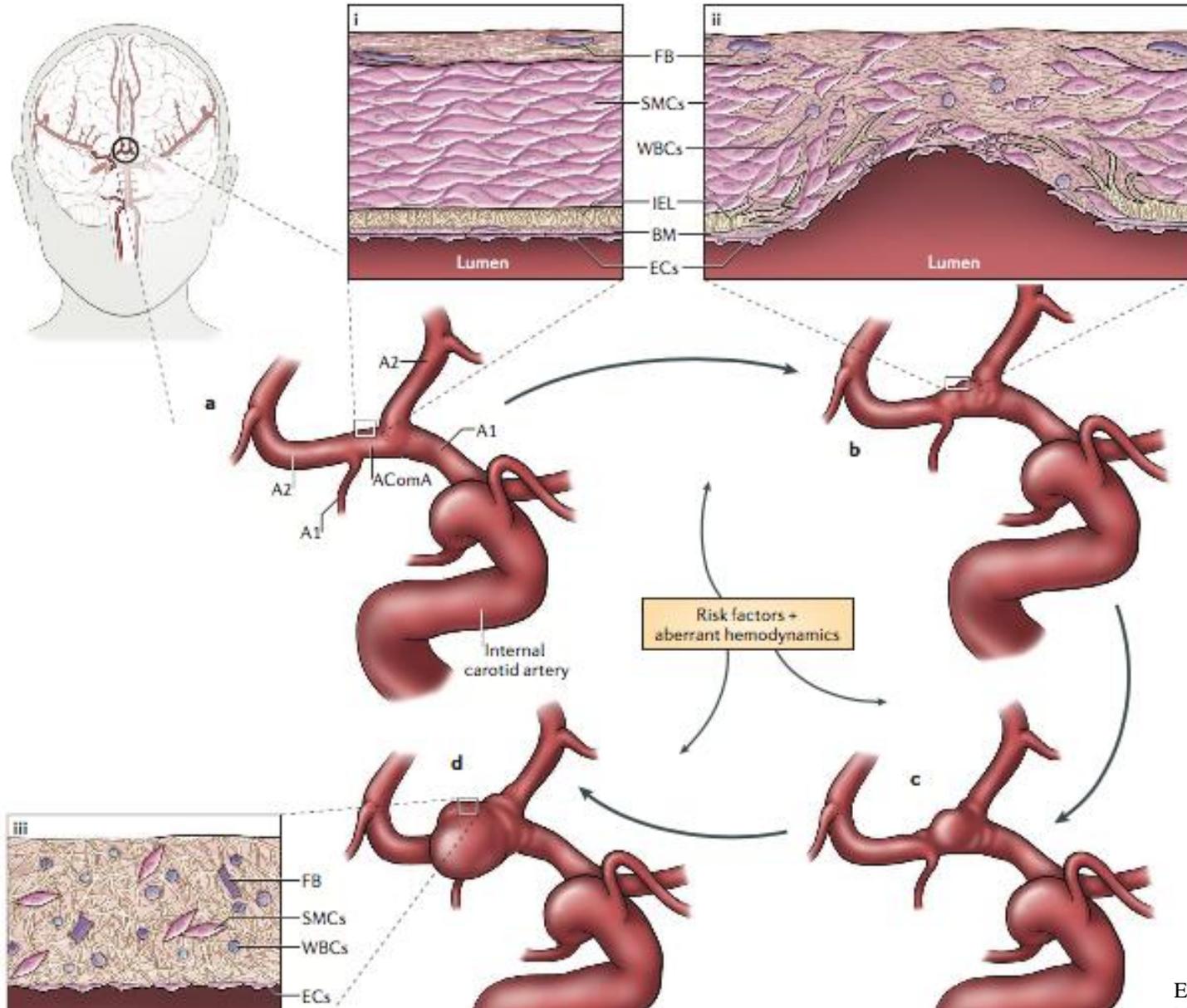
# aneurismi intracranici – key points

 migliore comprensione dei meccanismi di formazione e rottura degli aneurismi

 individuazione – e correzione – dei fattori di rischio

 definizione della strategia terapeutica preventiva ottimale

# patogenesi strutturale e molecolare



# fattori di rischio formazione e progressione

## non modificabili

- sesso femminile
- familiarità
- altri fattori genetici
- aneurismi multipli

## modificabili

- fumo
- ipertensione
- cocaina
- (fenomeni infiammatori)

# infiammazione e parete dell'aneurisma

- numerosi studi recenti
- ruolo chiave per la progressione e la rottura
- MR ad alta definizione (macrofagi)
- meccanismi molecolari e mediatori del processo infiammatorio ( NTF, IL-1 $\beta$ , COX-1, COX-2)
- studi clinici

# infiammazione e rischio di rottura

## **Aspirin as a Promising Agent for Decreasing Incidence of Cerebral Aneurysm Rupture**

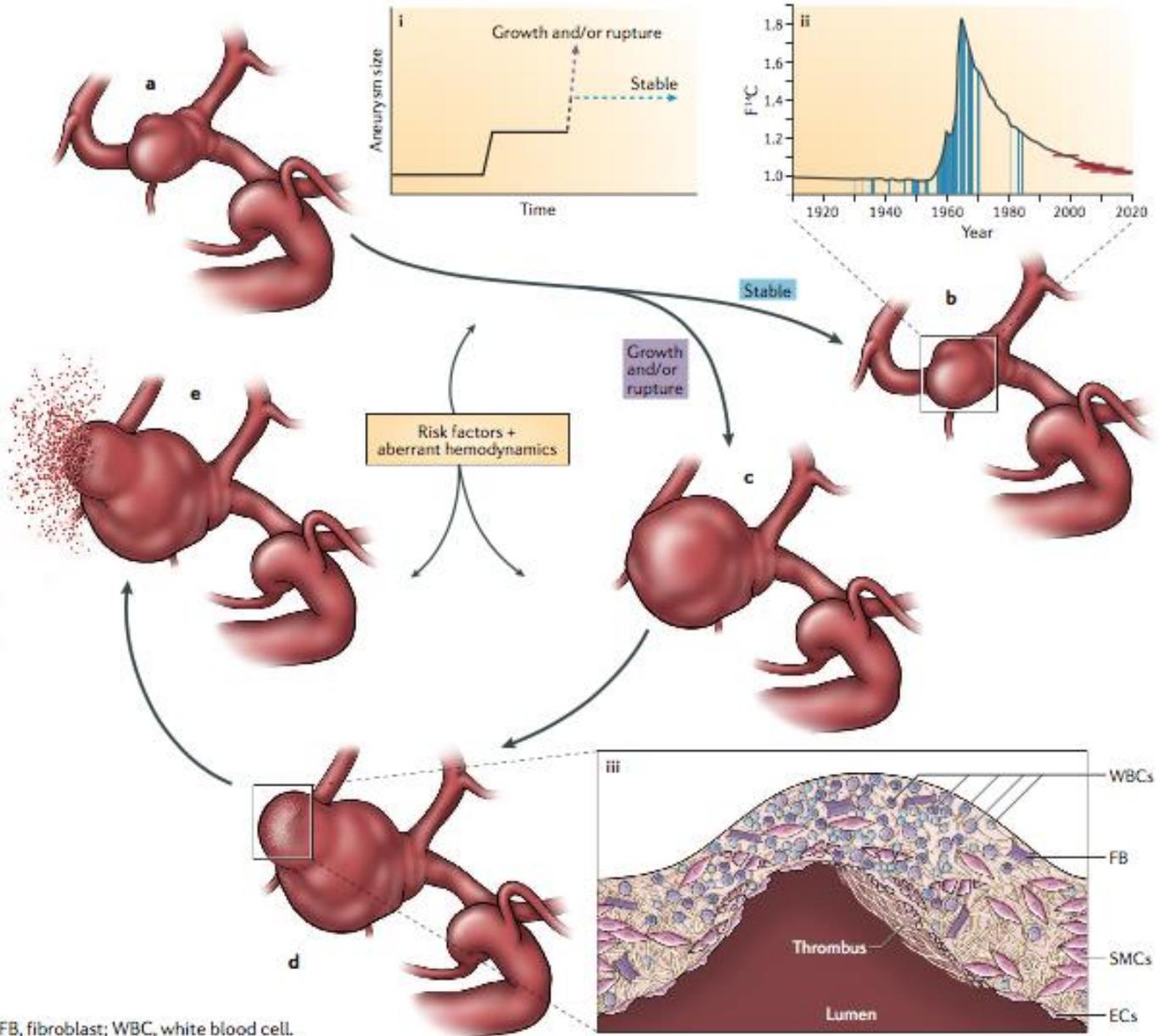
David M. Hasan, MD; Kelly B. Mahaney, MD; Robert D. Brown, Jr, MD, MPH; Irene Meissner, MD; David G. Piepgras, MD; John Huston, MD; Ana W. Capuano, MPS, MS; James C. Torner, PhD; for the International Study of Unruptured Intracranial Aneurysms Investigators

**Stroke**

JOURNAL OF THE AMERICAN HEART ASSOCIATION



# aneurismi intracranici – progressione e rottura



FB, fibroblast; WBC, white blood cell.

# analisi del rischio di rottura

- progressione non lineare, episodi stocastici di crescita fino a rottura
- prolungata stabilità, aumento delle dimensioni senza rottura
- prolungata stabilità, rottura senza aumento delle dimensioni
- rapida crescita e rottura senza un periodo di stabilità

# analisi del rischio di rottura

- è possibile che in futuro si arrivi a prevedere con precisione quali aneurismi sono destinati a rompersi

# analisi del rischio di rottura

---

## **Development of the PHASES score for prediction of risk of rupture of intracranial aneurysms: a pooled analysis of six prospective cohort studies**

*Jacoba P Greving, Marieke J H Wermer, Robert D Brown Jr, Akio Morita, Seppo Juvela, Masahiro Yonekura, Toshihiro Ishibashi, James C Torner, Takeo Nakayama, Gabriël J E Rinkel, Ale Algra*

Lancet Neurol 13, 59-66, 2014

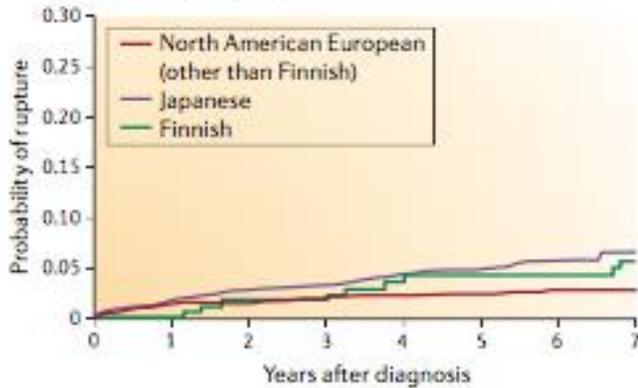
# analisi del rischio di rottura

## 6 fattori indipendenti di rischio

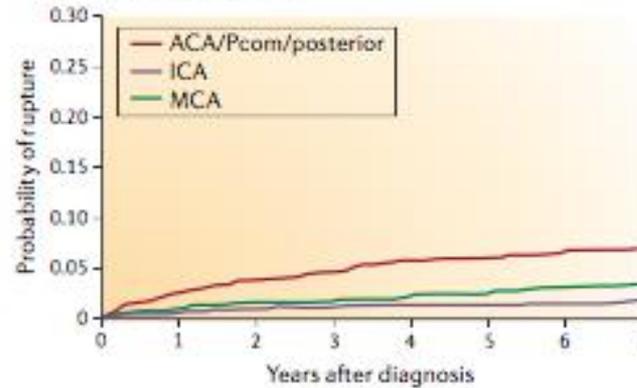
- età  $\leq 70$  anni
- storia di ipertensione
- pregressa SAH da rottura di un altro aneurisma
- dimensione dell'aneurisma
- sede dell'aneurisma
- origine geografica del paziente

# analisi del rischio di rottura

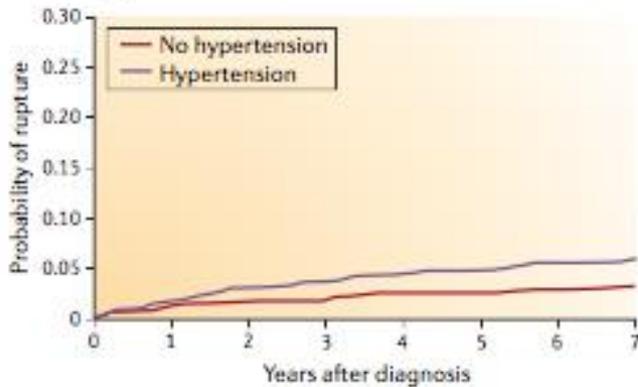
**a Geographical location**



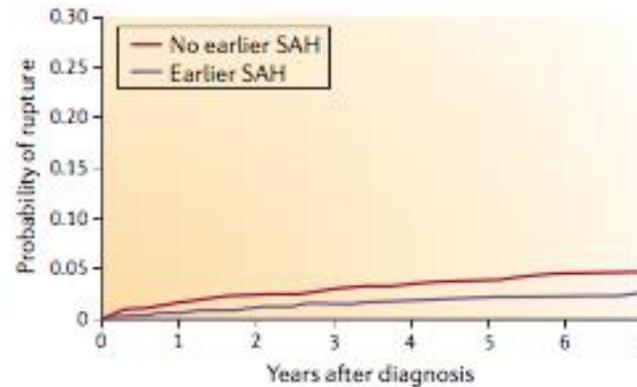
**b Aneurysm location**



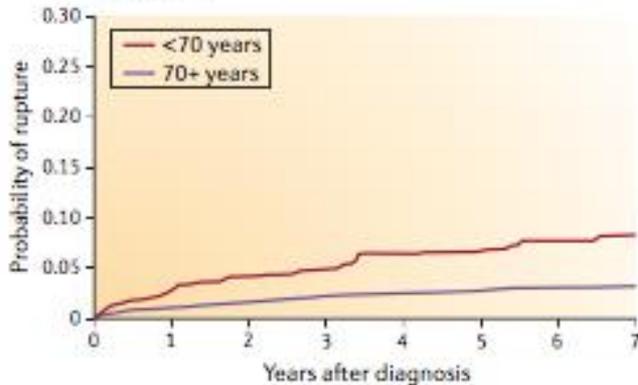
**c Hypertension**



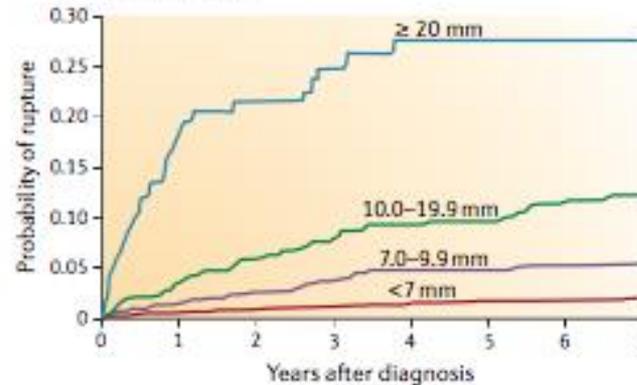
**d Earlier SAH**



**e Patient age**



**f Aneurysm size**



Greving JP et al,  
Lancet Neurol 13, 59-66, 2014

# PHASES risk score

PHASES aneurysm risk score	Points
<b>(P) Population</b>	
North American, European (other than Finnish)	0
Japanese	3
Finnish	5
<b>(H) Hypertension</b>	
No	0
Yes	1
<b>(A) Age</b>	
<70 years	0
≥70 years	1
<b>(S) Size of aneurysm</b>	
<7.0 mm	0
7.0–9.9 mm	3
10.0–19.9 mm	6
≥20 mm	10
<b>(E) Earlier SAH from another aneurysm</b>	
No	0
Yes	1
<b>(S) Site of aneurysm</b>	
ICA	0
MCA	2
ACA/Pcom/posterior	4

Greving JP et al,  
Lancet Neurol 13, 59-66,  
2014

# analisi del rischio di rottura

## The unruptured intracranial aneurysm treatment score

A multidisciplinary consensus

OPEN

Neurology®

Etminan N et al, Neurology 85, 881-889, 2015

# analisi del rischio di rottura

- inclusione di altri importanti fattori di rischio
- patient-related (fumo, familiarità, fattori genetici, ecc)
- aneurysm-related (morfologia, angolo di flusso nella sacca)

Etminan N et al, Neurology 85, 881-889, 2015

# UIAT score

Patient			Aneurysm			Treatment						
Age (single)	< 40 years	4	<input type="checkbox"/>	Maximum diameter (single)	≤ 3.9 mm	0	<input type="checkbox"/>					
	40-60 years	3			4.0-6.9 mm	1						
	61-70 years	2			7.0-12.9 mm	2						
	71-80 years	1			13.0-24.9 mm	3						
	> 80 years	0			≥ 25 mm	4						
	Risk factor incidence (multiple)	Previous SAH from a different aneurysm			4	<input type="checkbox"/>		Morphology (multiple)	Irregularity or lobulation	3	<input type="checkbox"/>	
		Familial intracranial aneurysms or SAH			3				Size ratio > 3 or aspect ratio > 1.6	1		
		Japanese, Finnish, Inuit ethnicity			2			Location (single)	BasA bifurcation	5		<input type="checkbox"/>
		Current cigarette smoking			3				Vertebral/basilar artery	4		
		Hypertension (systolic BP > 140 mm Hg)			2			AcomA or PcomA	2	Other (multiple)		
Autosomal-polycystic kidney disease		2	Aneurysm de novo formation on serial imaging	3	Contralateral stenooclusive vessel disease		1					
Current drug abuse (cocaine, amphetamine)		2	Age-related risk (single)	< 40 years	0		<input type="checkbox"/>					
Current alcohol abuse		1		41-60 years	1							
Clinical Symptoms related to UIA (multiple)	Cranial nerve deficit	4	<input type="checkbox"/>	61-70 years	3	<input type="checkbox"/>						
	Clinical or radiological mass effect	4		71-80 years	4							
	Thromboembolic events from the aneurysm	3		> 80 years	5							
	Epilepsy	1		Aneurysm size-related risk (single)	< 6.0 mm			0	<input type="checkbox"/>			
Other (multiple)	Reduced quality of life due to fear of rupture	2	6.0-10.0 mm		1							
	Aneurysm multiplicity	1	10.1-20.0 mm	3	Aneurysm complexity-related risk			High		3	<input type="checkbox"/>	
Life expectancy due to chronic and/or malignant Diseases (single)	< 5 years	4	> 20 mm	5			Low	0				
	5 - 10 years	3	Intervention-related risk	Constant*			<input type="checkbox"/>					
	> 10 years	1		Comorbid disease (multiple)	Neurocognitive disorder	3		<input type="checkbox"/>				
Comorbid disease (multiple)	Coagulopathies, thrombophilic diseases	2	Psychiatric disorder		2	<input type="checkbox"/>						
	Favors UIA repair	Favors UIA conservative management										
			5									

- punteggio in favore del trattamento (chirurgico o endovascolare)
- punteggio in favore di un atteggiamento conservativo

trattamento preventivo

# analisi del rischio di rottura

- età, condizioni generali, co-morbilità
- dimensioni della sacca aneurismatica
- morfologia della sacca aneurismatica
- sede

# analisi del rischio di rottura

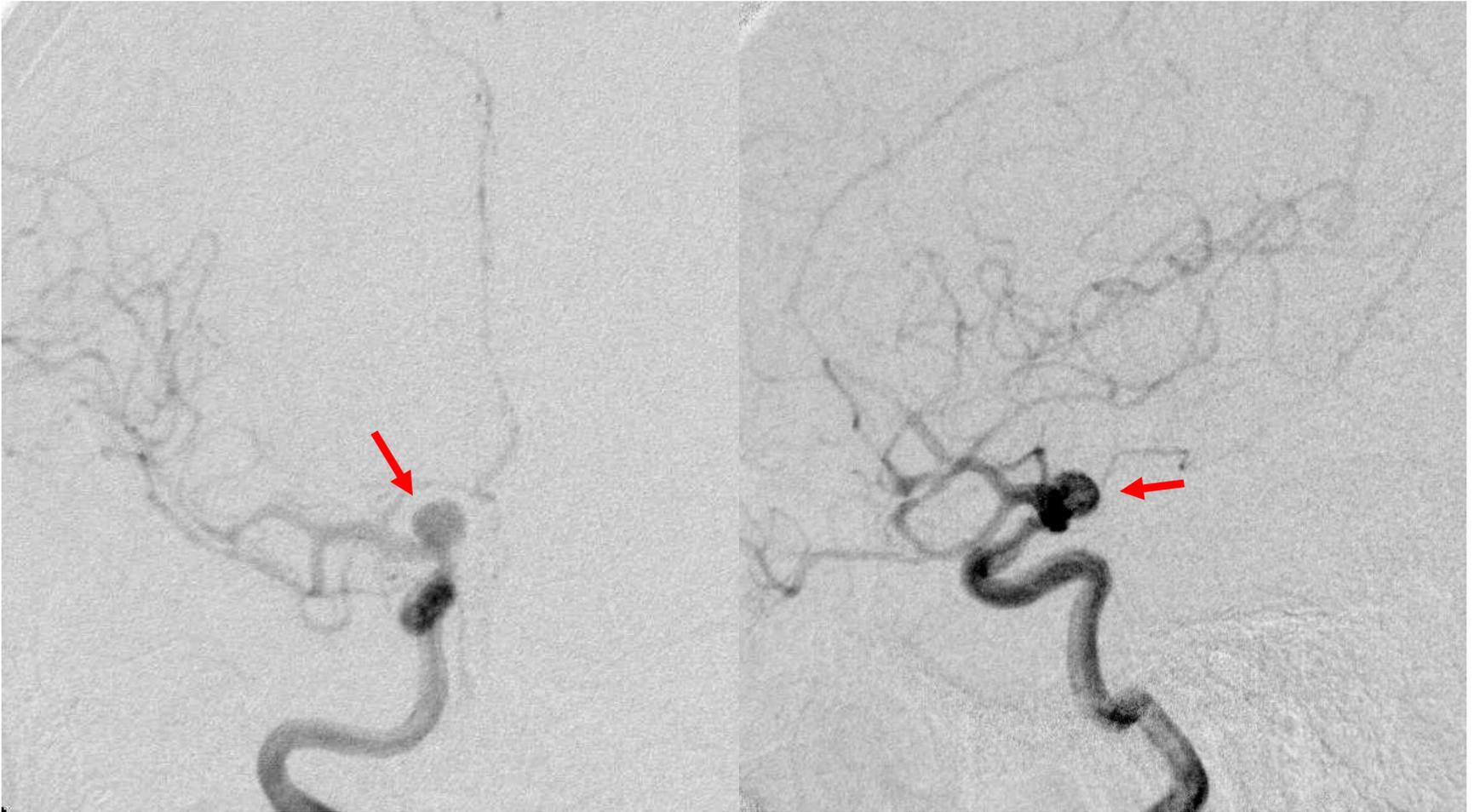
- rischio cumulativo di rottura
- variabile: dimensione della sacca
- cutoff: 5 mm o 7 mm?
- $< 7$  mm: 0.4 %/anno
- $> 7$  mm: 1.4-2 %/anno

# morfologia della sacca - blister aneurysm



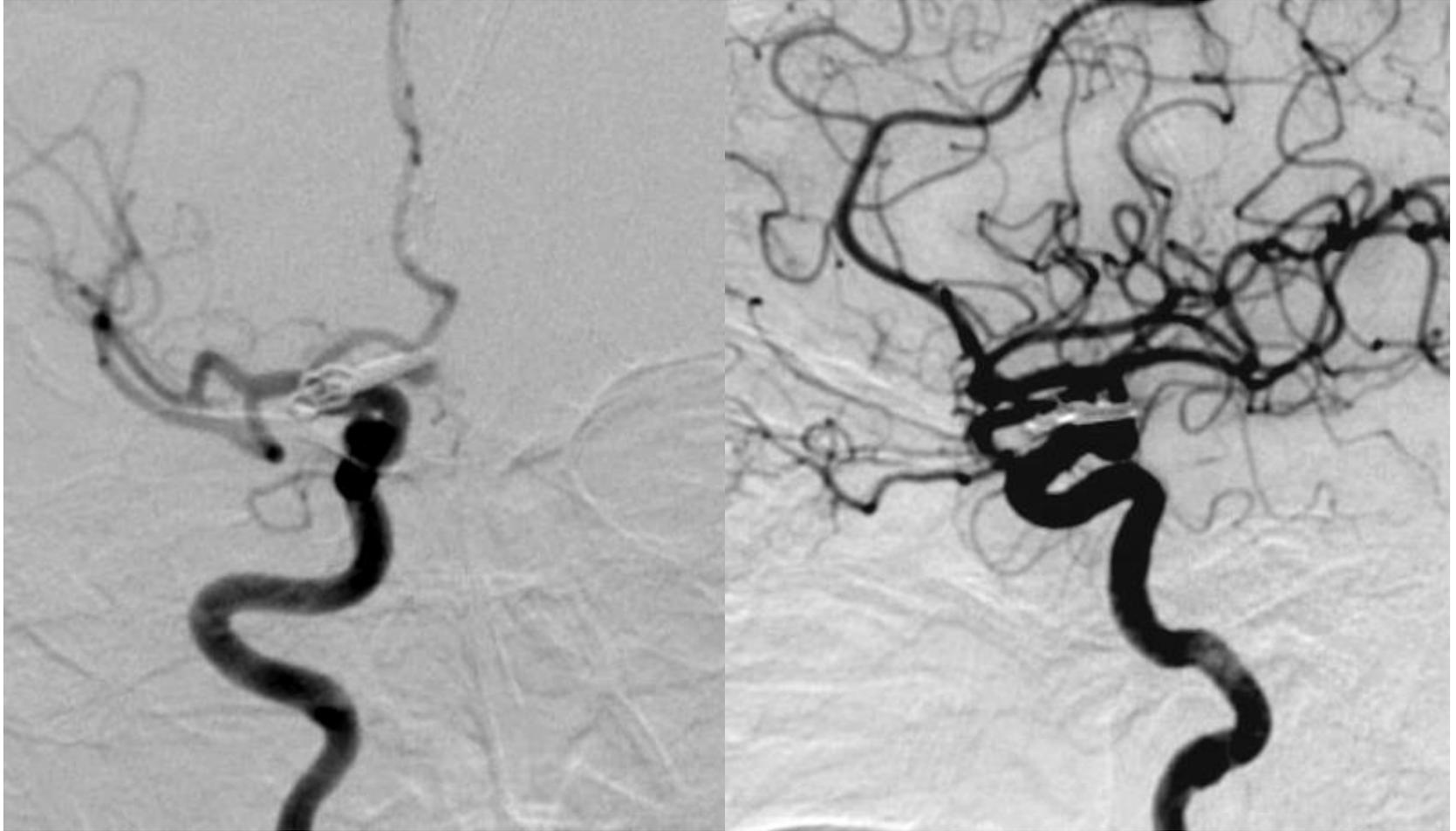
6.3.2006

# morfologia: blister aneurysm



22.3.2006

# morfologia blister aneurysm



30.3.2006

## morfologia della sacca

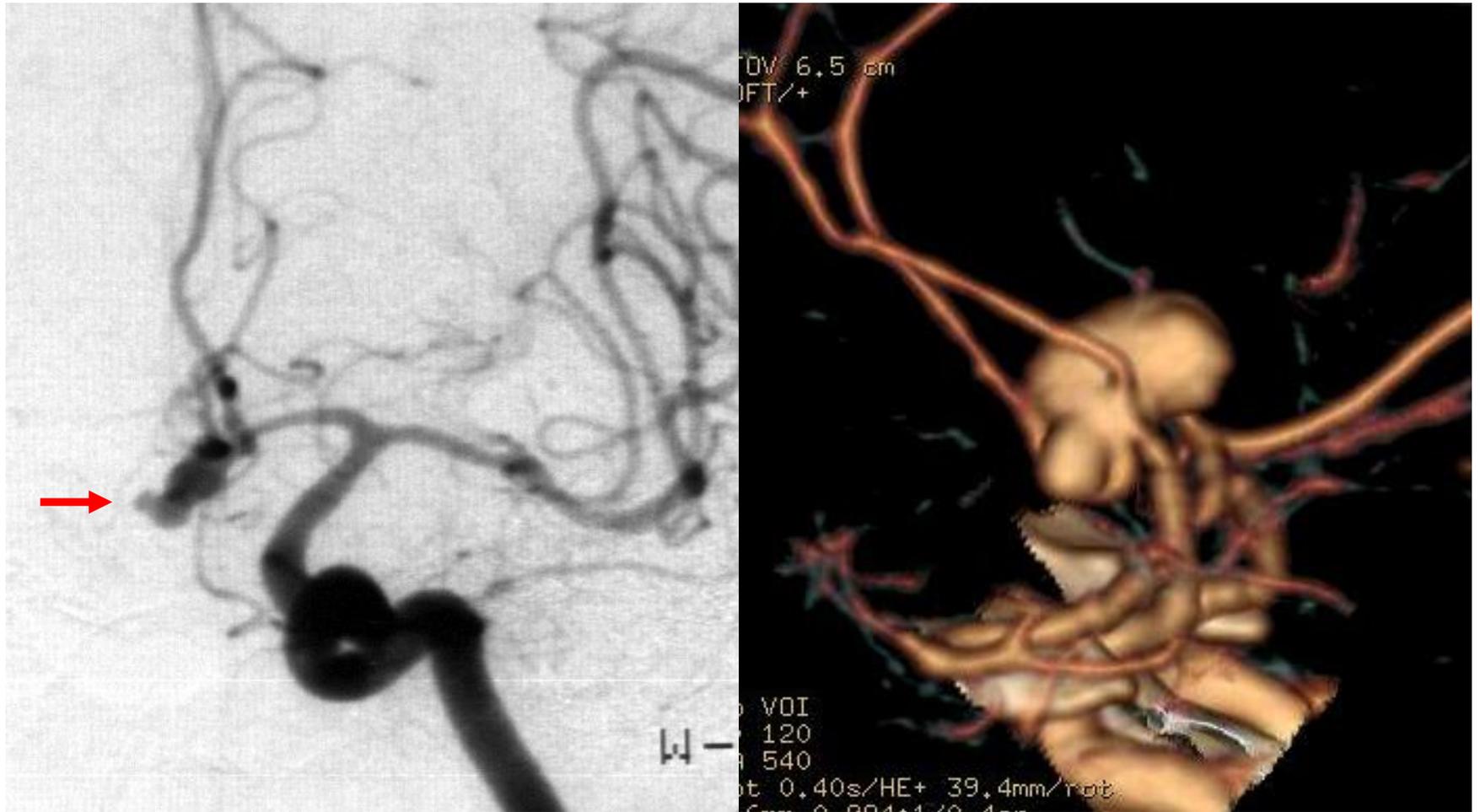


- daughter sac
- forma oblunga
- morfologia irregolare

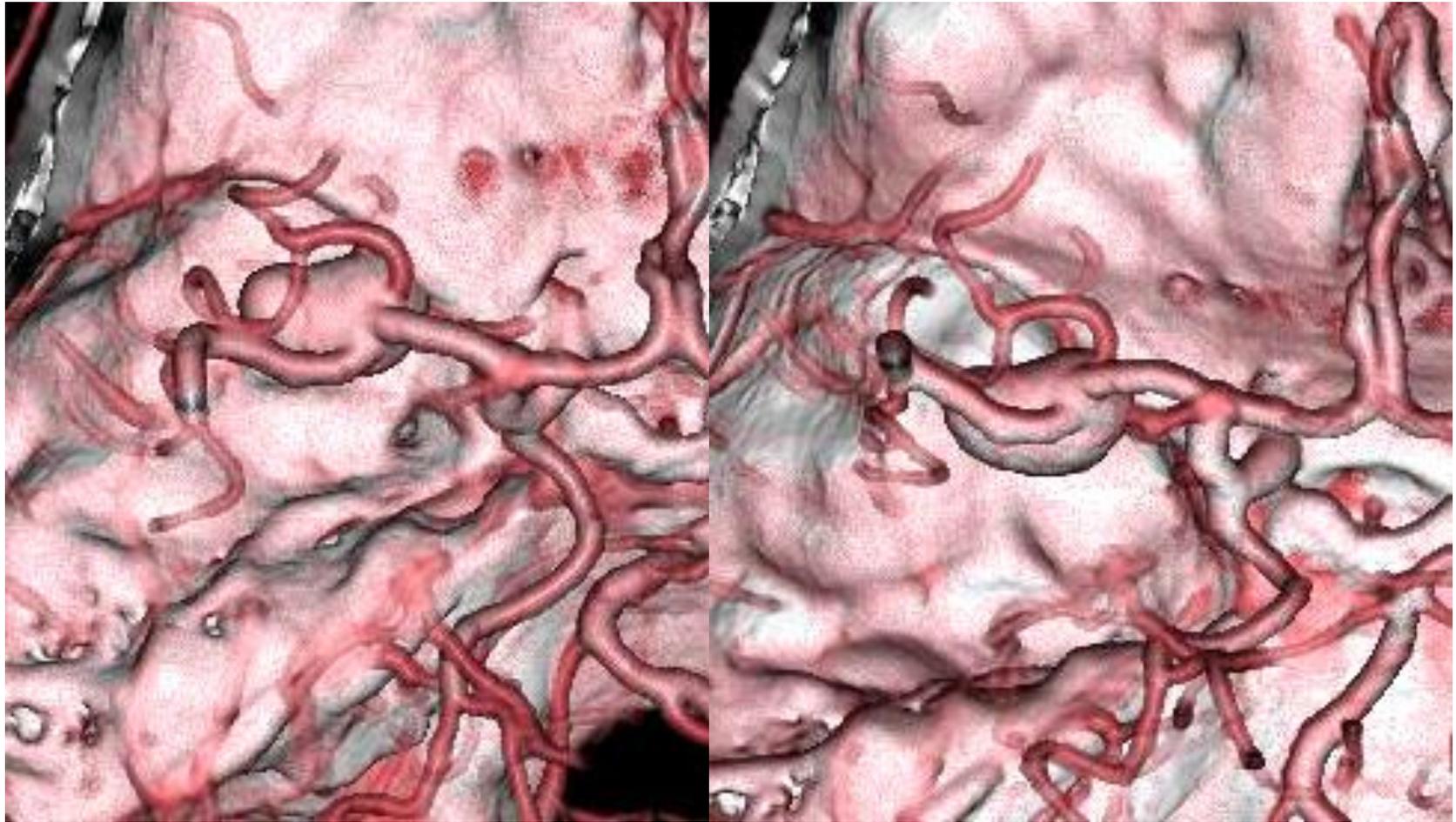


aumento del rischio  
di rottura

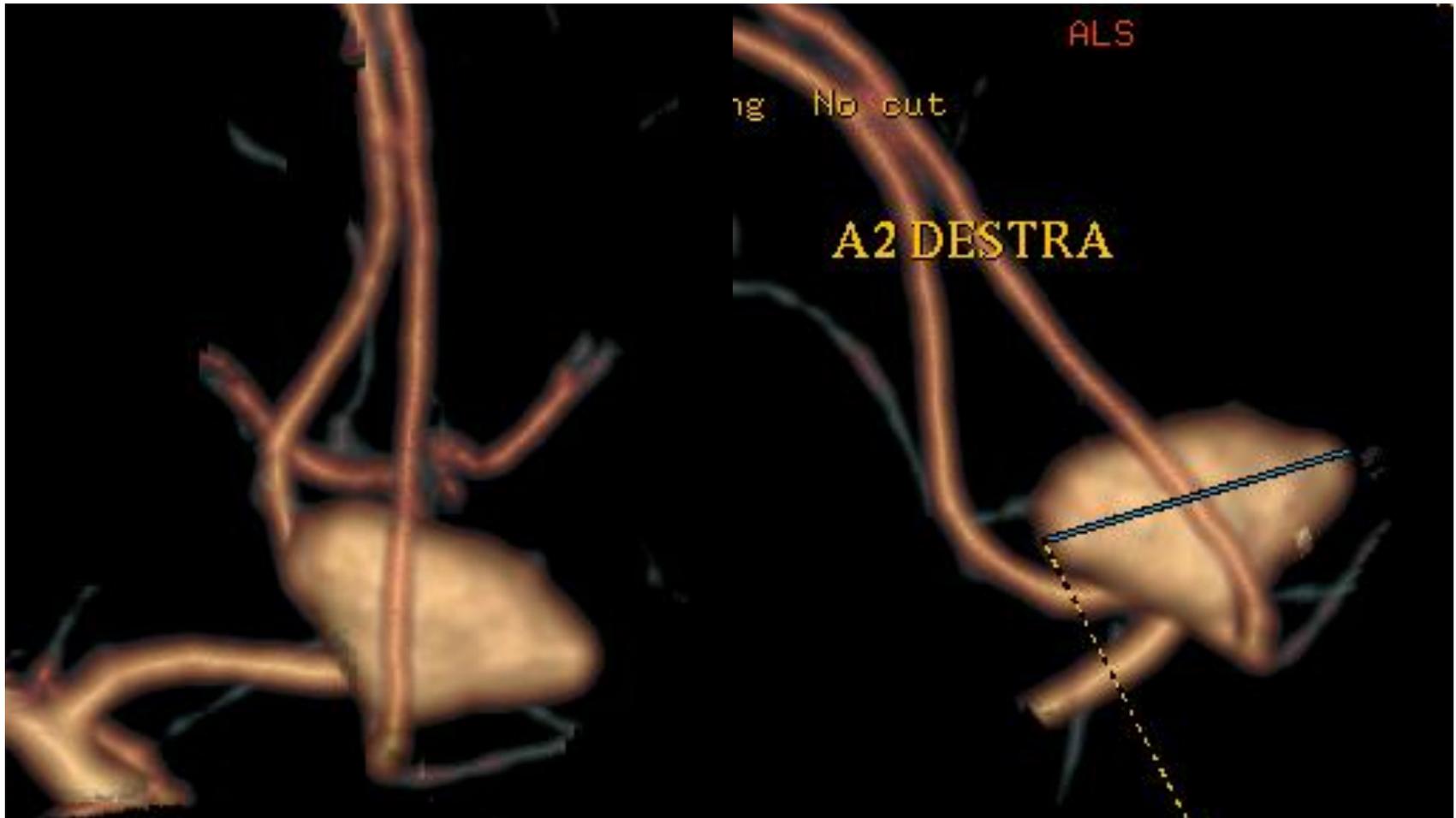
# morfologia della sacca



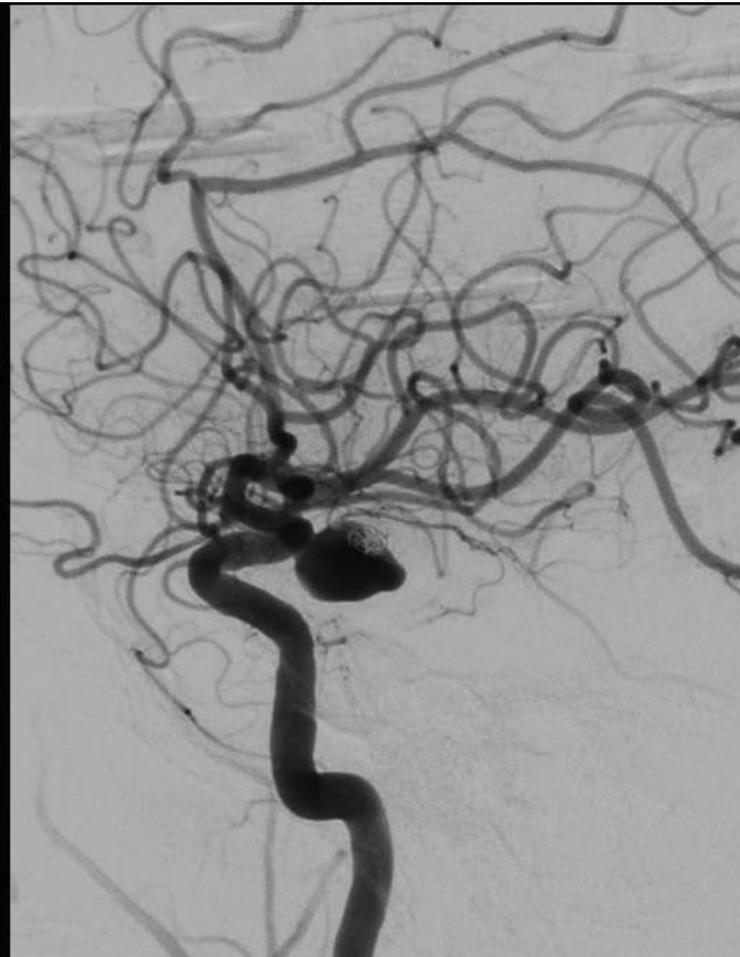
## sedi di più semplice accesso - CM



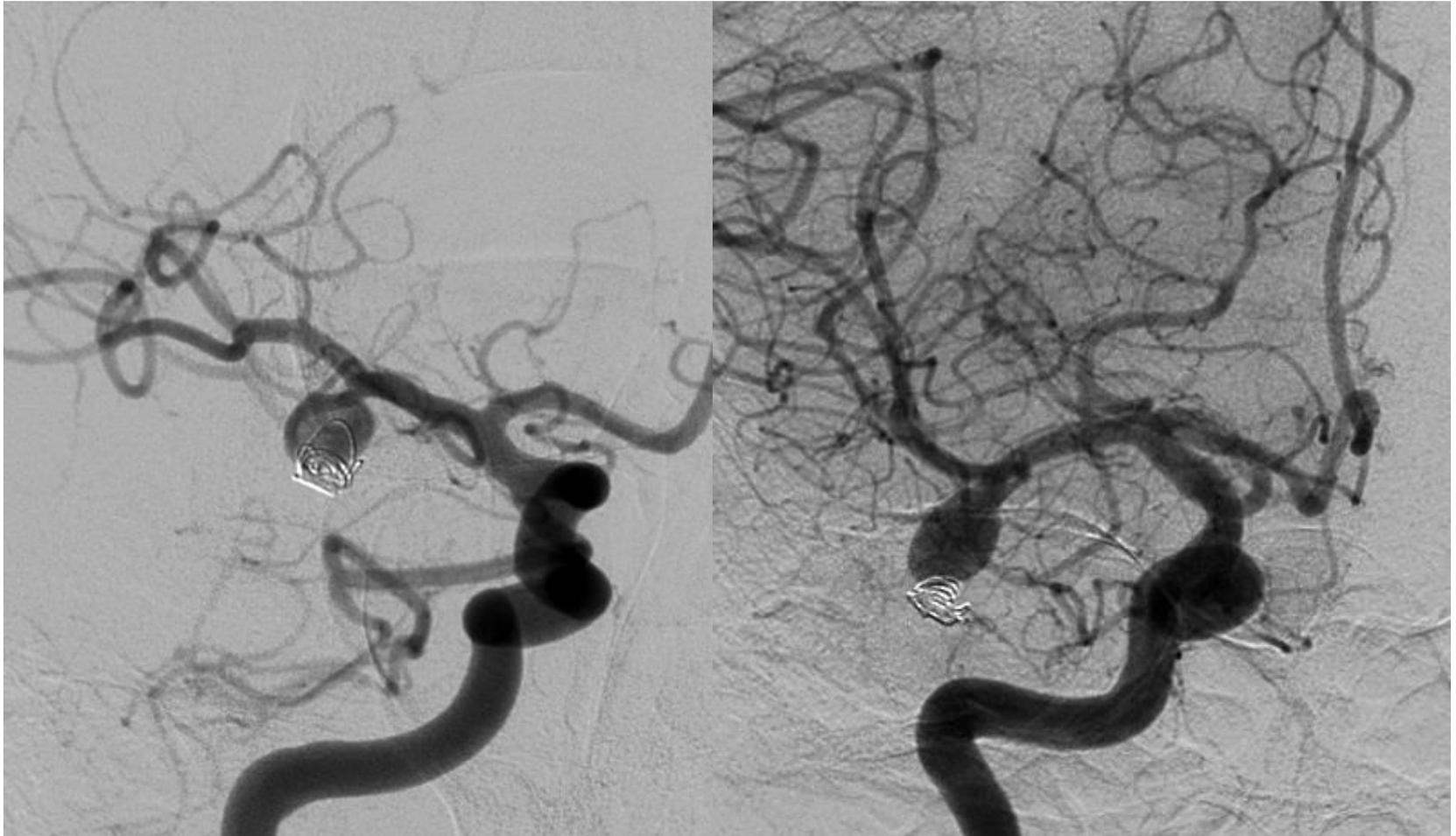
# sedi di più semplice accesso - CCA



sedi di più semplice accesso – CI /CCP



# precedente trattamento endovascolare



# trattamento chirurgico

RESEARCH PAPER

## Safety and occlusion rates of surgical treatment of unruptured intracranial aneurysms: a systematic review and meta-analysis of the literature from 1990 to 2011

Marc Kotowski,<sup>1,2</sup> Olivier Naggara,<sup>3</sup> Tim E Darsaut,<sup>1,4,5</sup> Suzanne Nolet,<sup>5</sup>  
Guylaine Gevry,<sup>5</sup> Evgueni Kouznetsov,<sup>1</sup> Jean Raymond<sup>1,5</sup>

J Neurol Neurosurg Psychiatry 84: 42-48, 2013

# trattamento chirurgico - 1

- metanalisi (1990 – 2011): 60 studi, 9845 pazienti, 10845 aneurismi non rotti
- morbilità post-chirurgica complessiva: 6.7% (99% CI: 4.9 – 9%)
- mortalità: 1.7 % (99% CI: 0.7 – 3%)
- limite: 85% studi retrospettivi

## trattamento chirurgico – 2

- valutazione dell'esclusione: 32% degli studi
- 2180 aneurismi non rotti

esclusione	completa	residuo al colletto	incompleta
%	91.8	3.9	4.3

## trattamento chirurgico – 3

- sanguinamento dopo chirurgia:
- 773 pazienti valutati (7.9 %) in 9 studi
- 3 sanguinamenti (0.38%), media di osservazione 1.2 anni

# aneurismi intracranici intatti

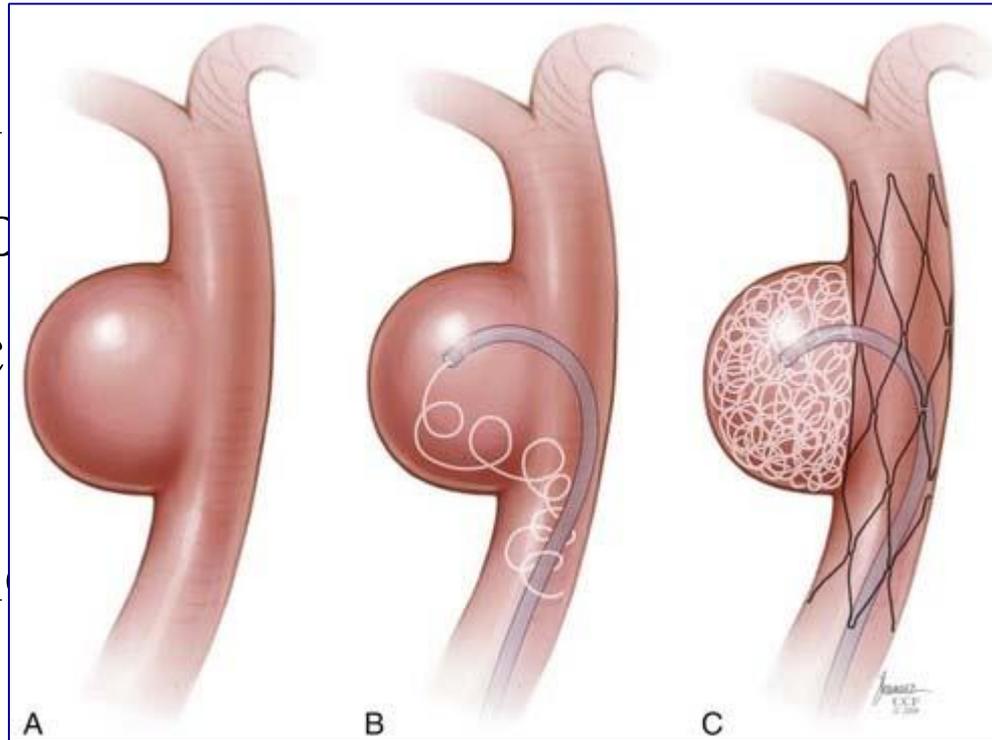
## vantaggi della chirurgia

- risoluzione rapida
- durata nel tempo
- non necessità (assoluta) di controlli a lungo termine

# aneurismi intracranici intatti

## selezione per la chirurgia - 1

- pazienti
- rapporto
- sedi acc (CCA)
- dimensi



chirurgico

M, sifone,

# difficult aneurysms - features

- Large/giant size
- Location of difficult access
- Unfavourable configuration:
  - broad neck
  - spherical/fusiform shape
  - branches arising from aneurysm itself
  - origin on unfavourable branching:
    - > arrow-shaped MCA division
    - > “angular” origin
  - double sac
  - dysplasia of parent artery

# difficult aneurysms - features

- Branches adjacent/adherent to aneurysm
  - perforators adjacent to neck
  - efferent branches strictly adherent to aneurysm
- Abnormal wall structure
  - blister aneurysm
  - calcified/atherosclerotic wall
- Intraluminal thrombus
- Degree of collateral circulation
- Embedding in brain tissue or cranial nerve
- Previous treatment:
  - coiling
  - clipping

# aneurismi intracranici intatti

## selezione per la chirurgia - 2

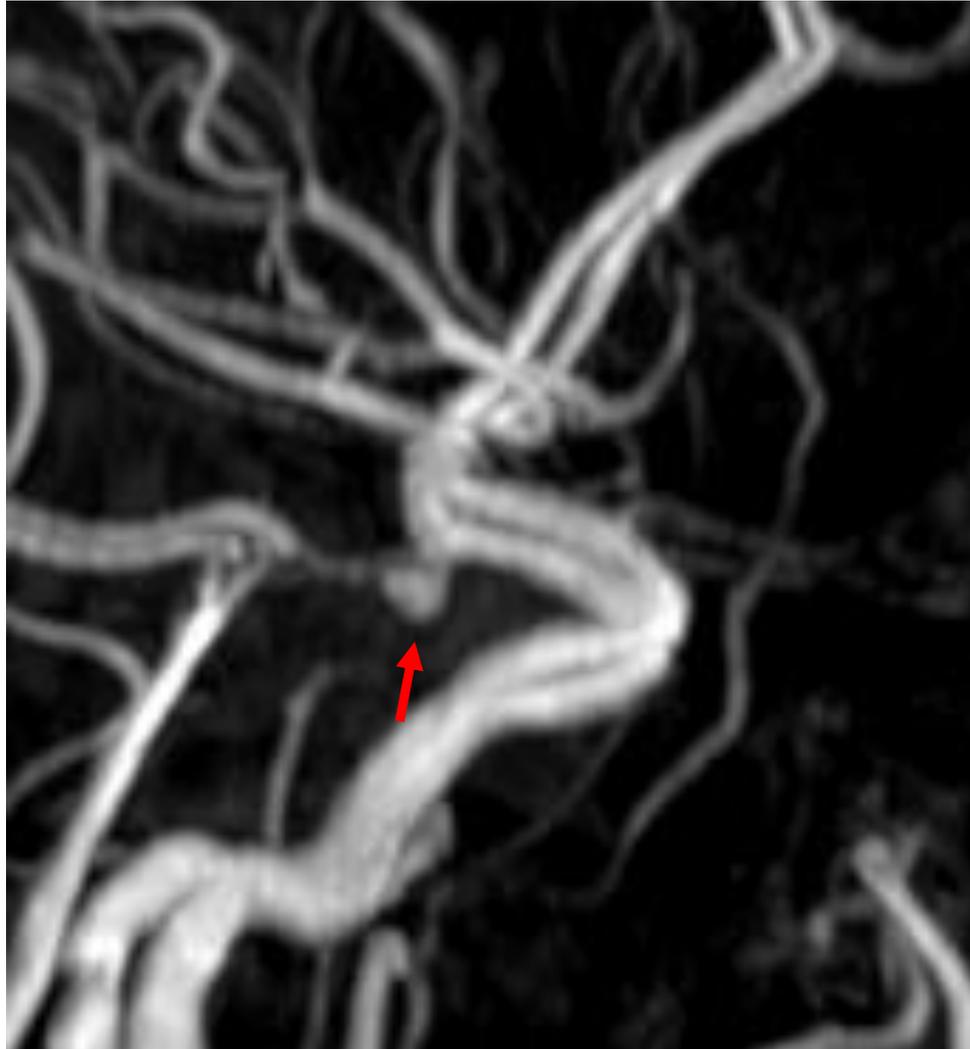
- fallimento del trattamento endovascolare
- aneurismi molto complessi
- decisione del paziente

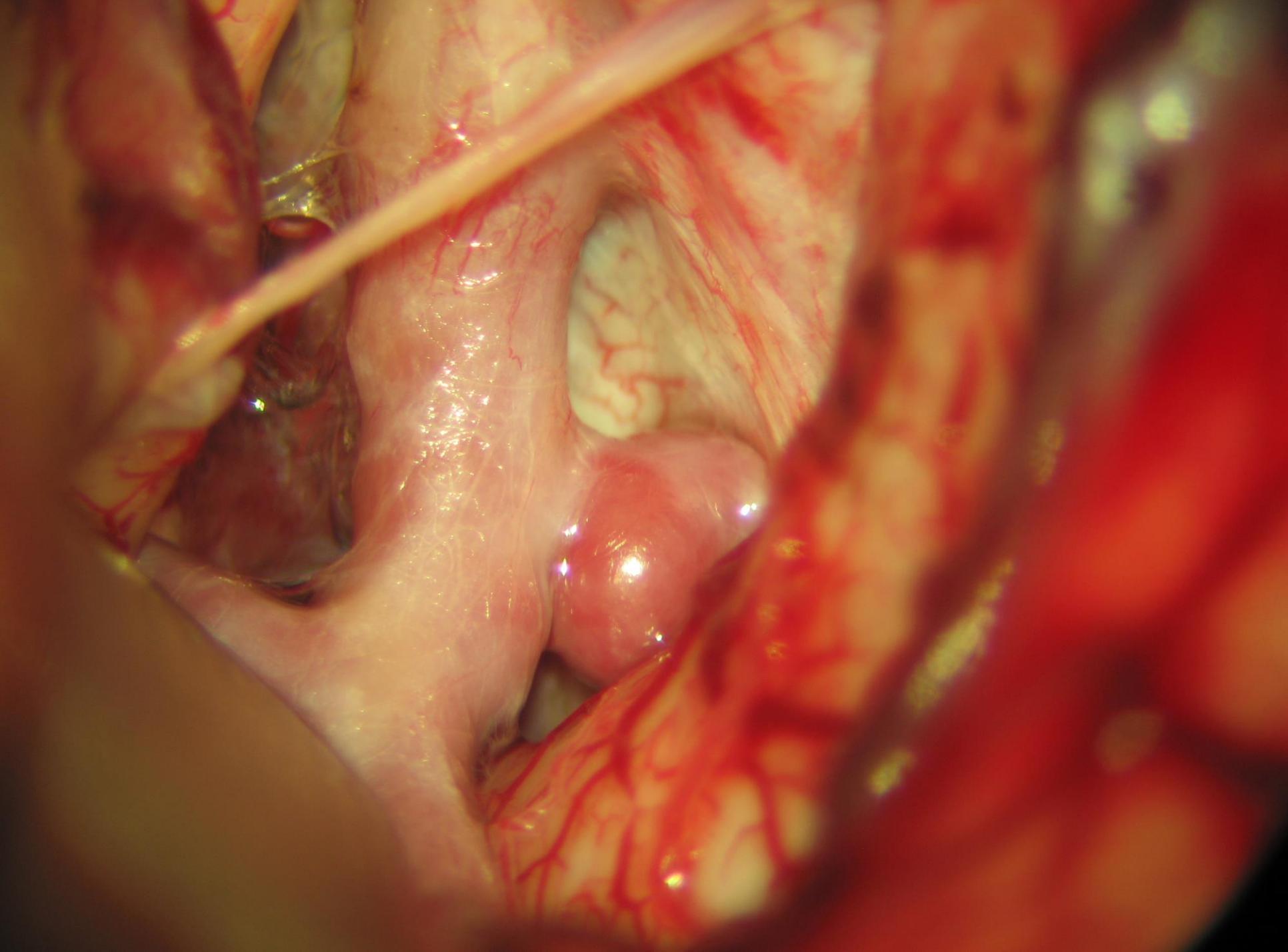
# aneurismi intracranici intatti

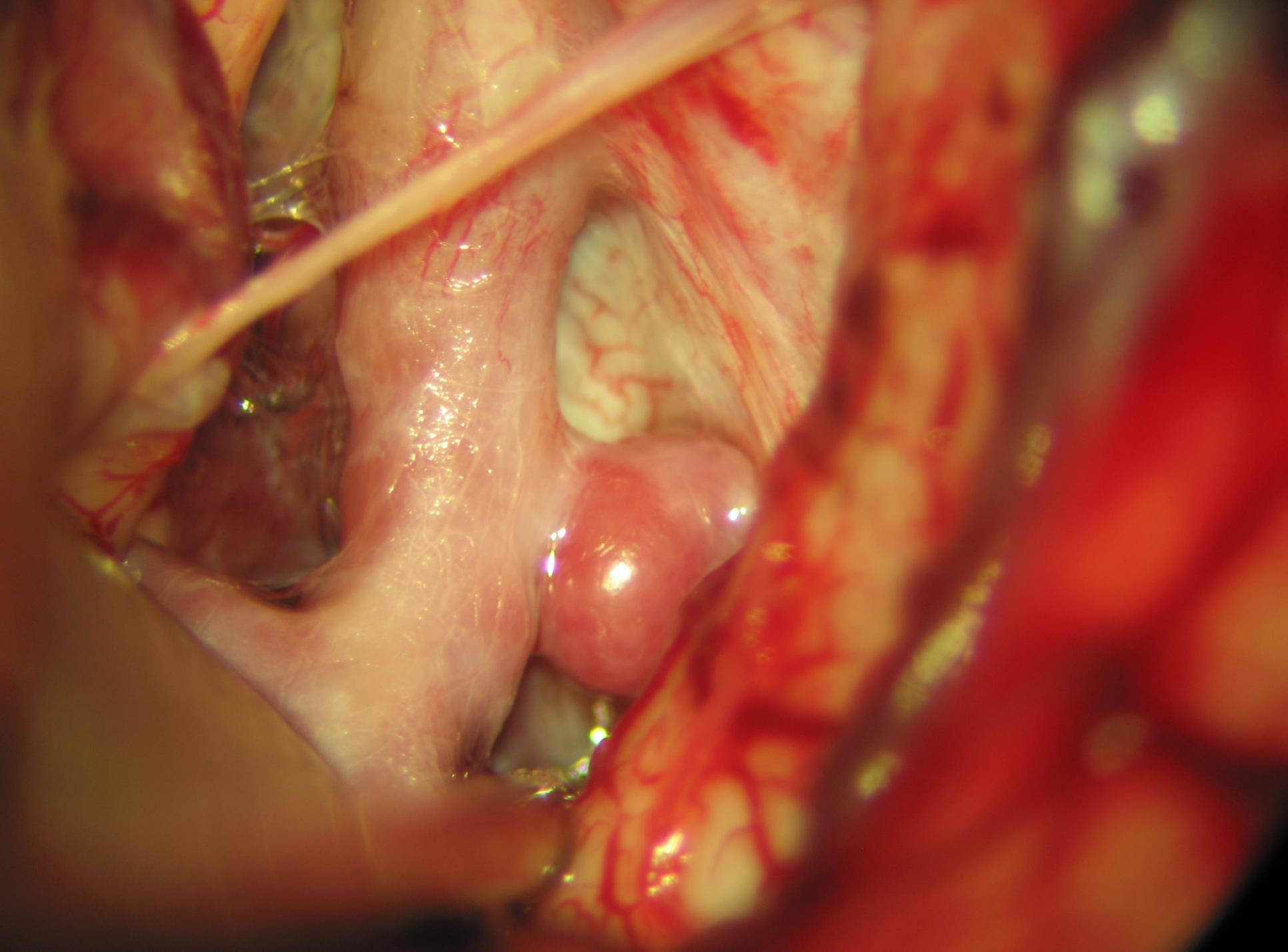
## selezione per la chirurgia - 3

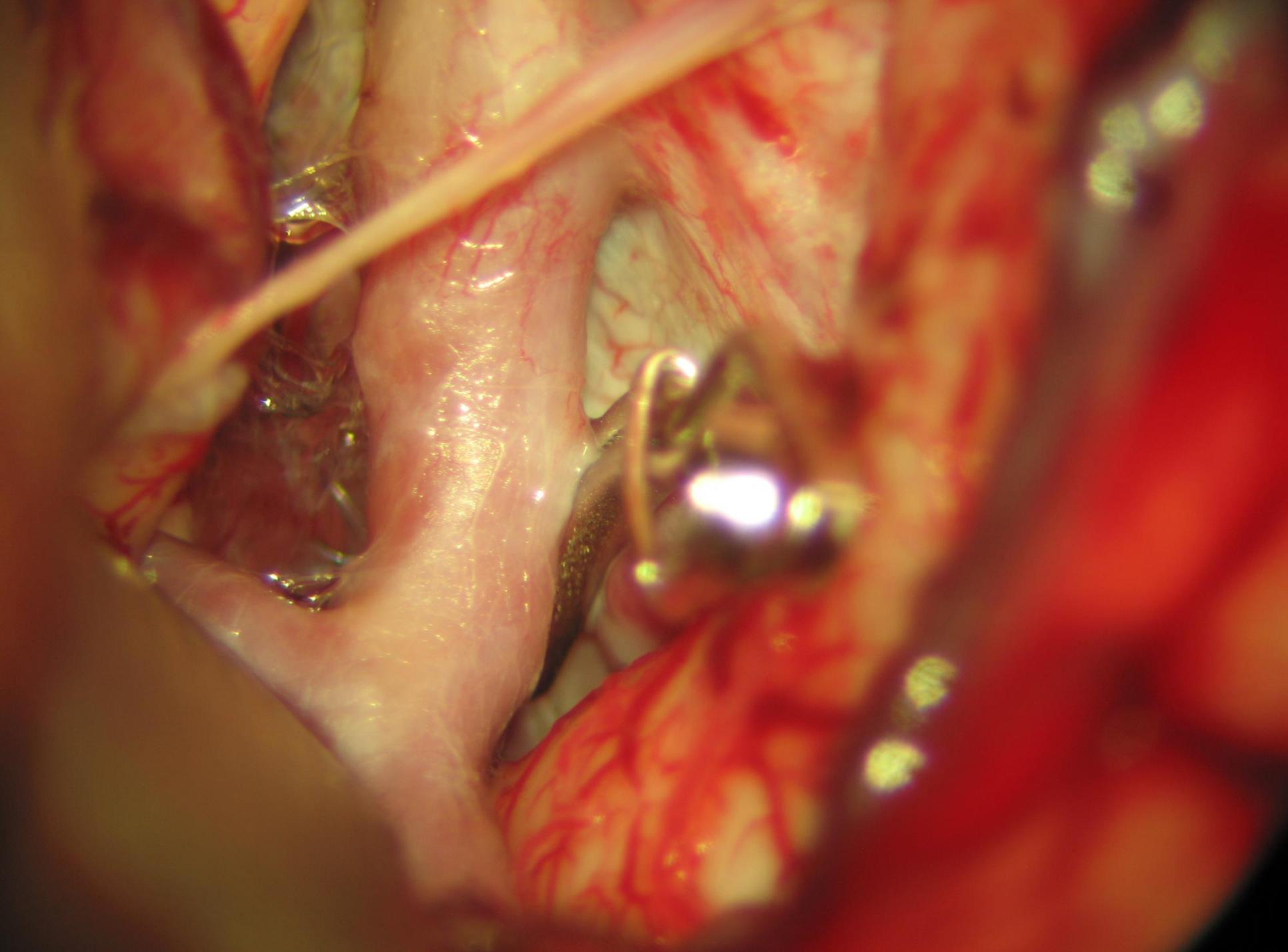
- ➔ valutazione con il neuroradiologo interventzionale
- ➔ esperienza personale, casistica e risultati

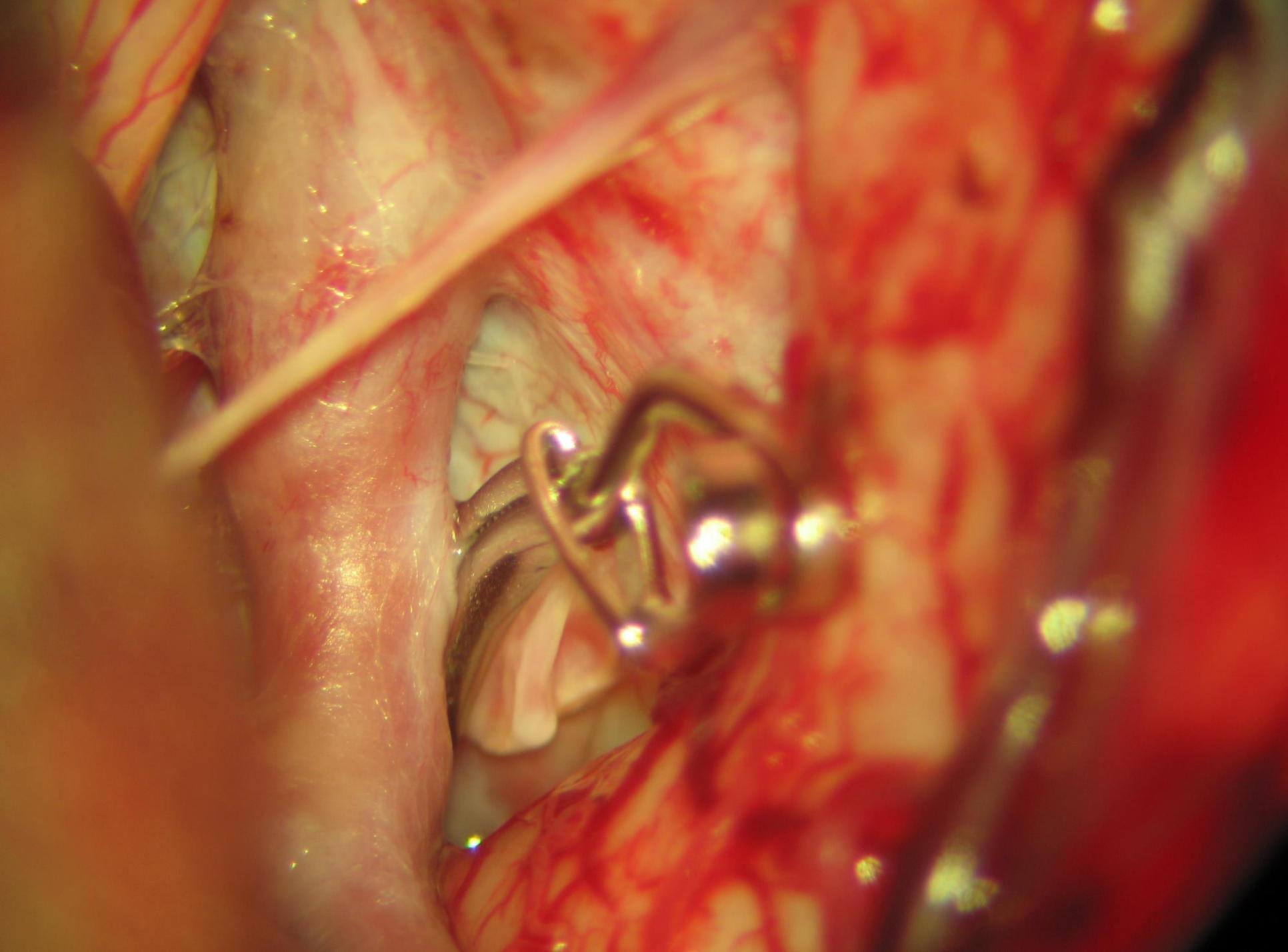
DMF ♂, 51 a, sifone Dx/CCP



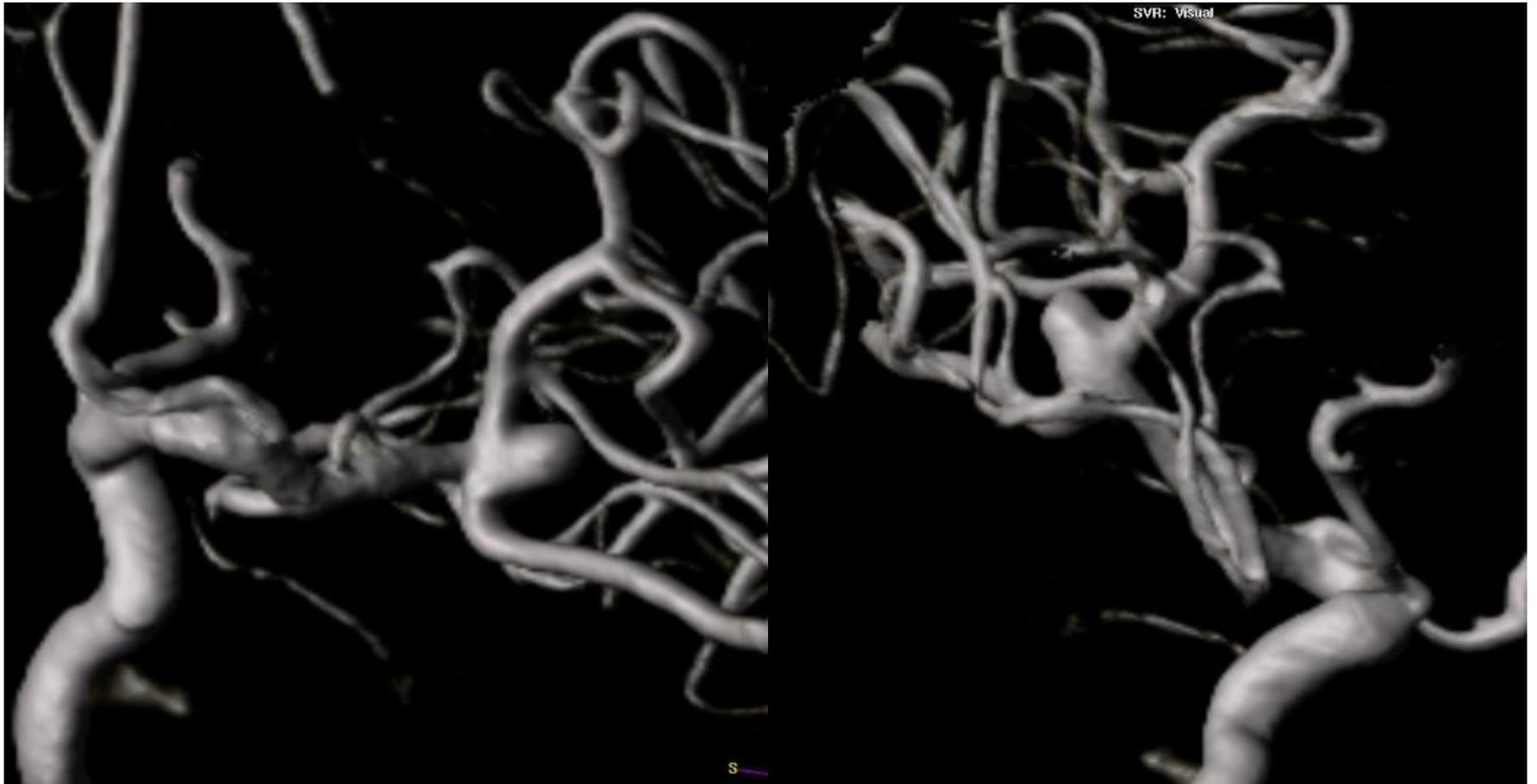








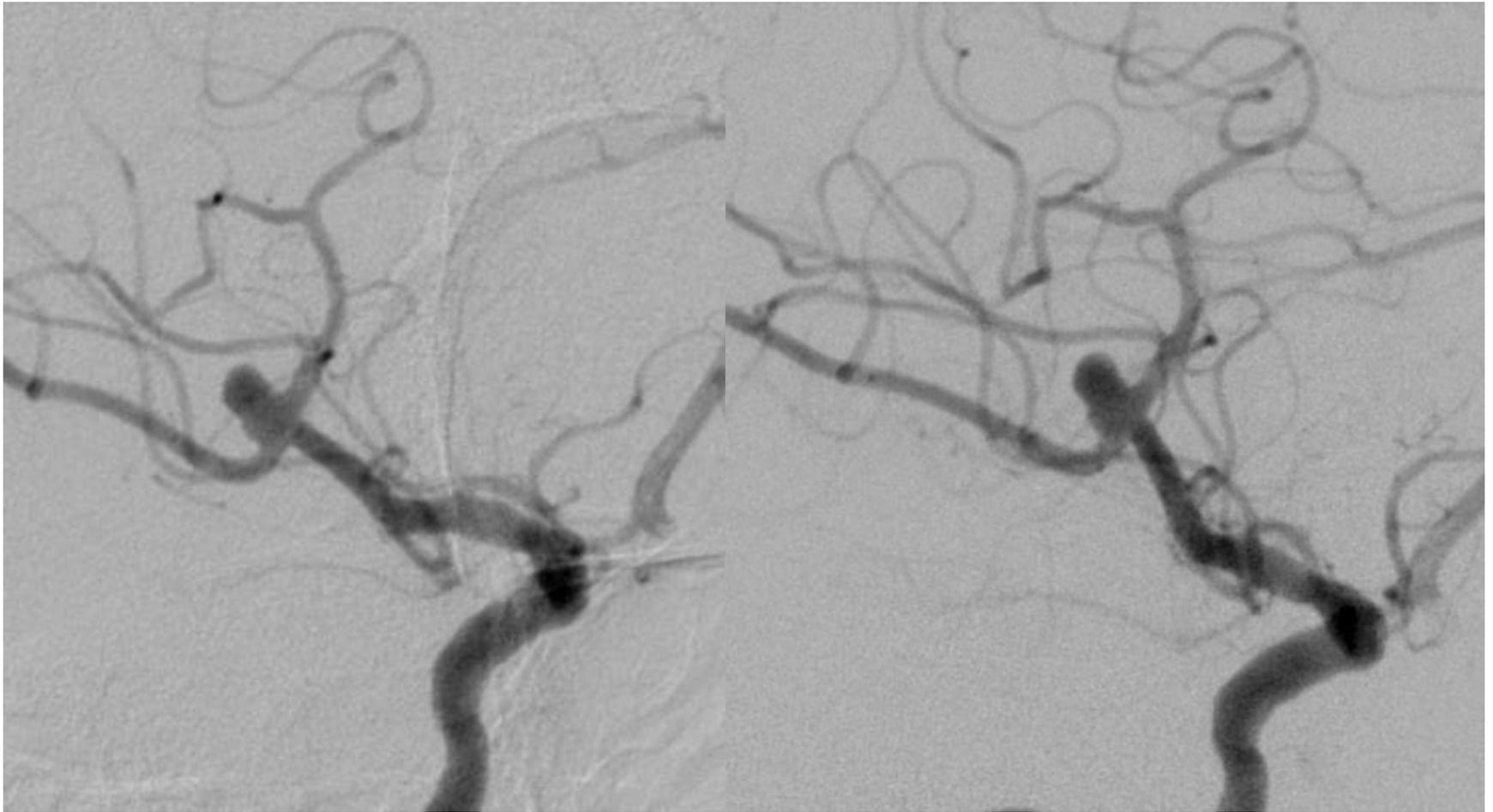
B.A. ♀, 57 a, CM Sn, proiezione superiore



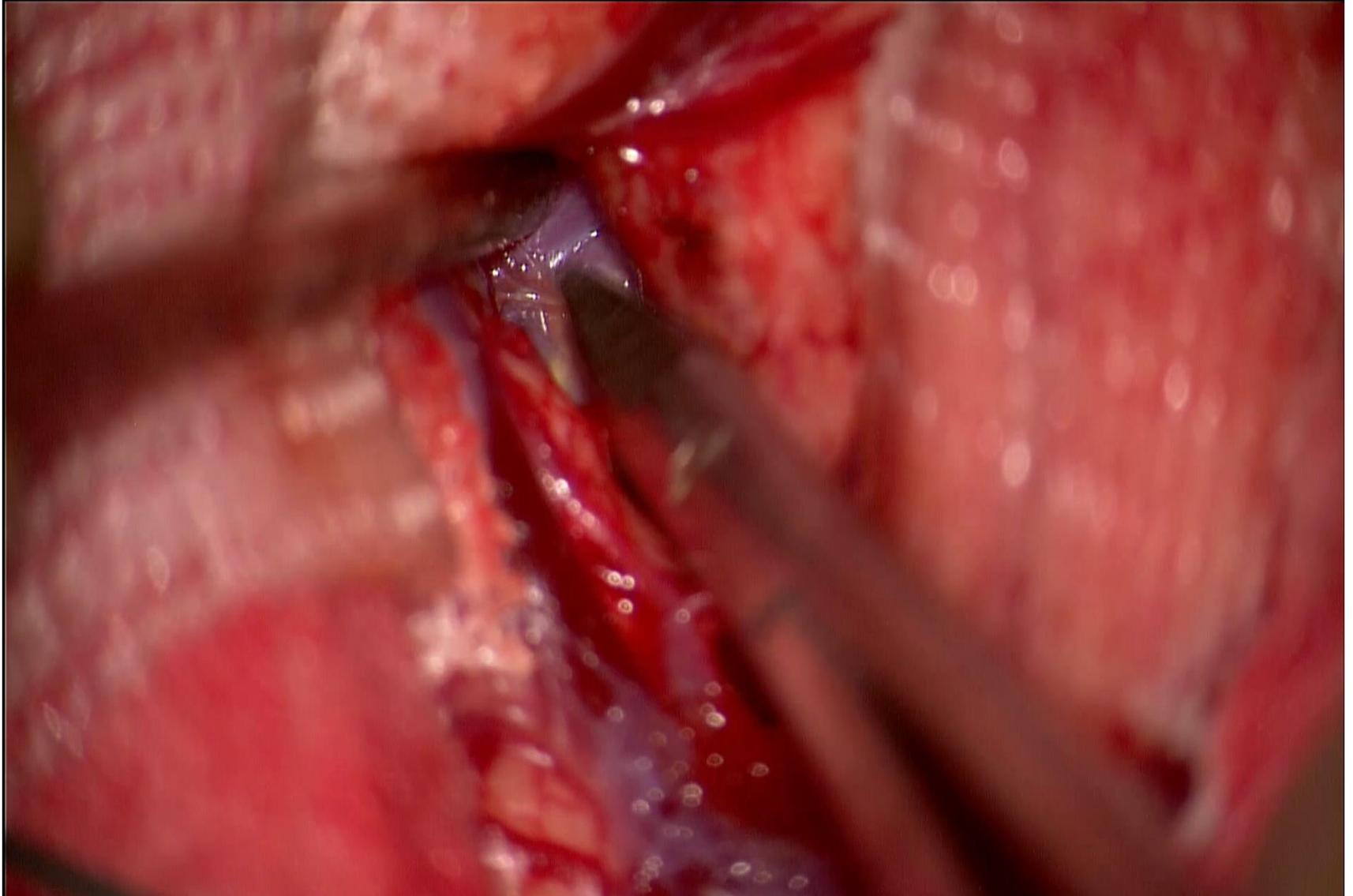
B.A. ♀, 57 a, CM Sn, proiezione superiore



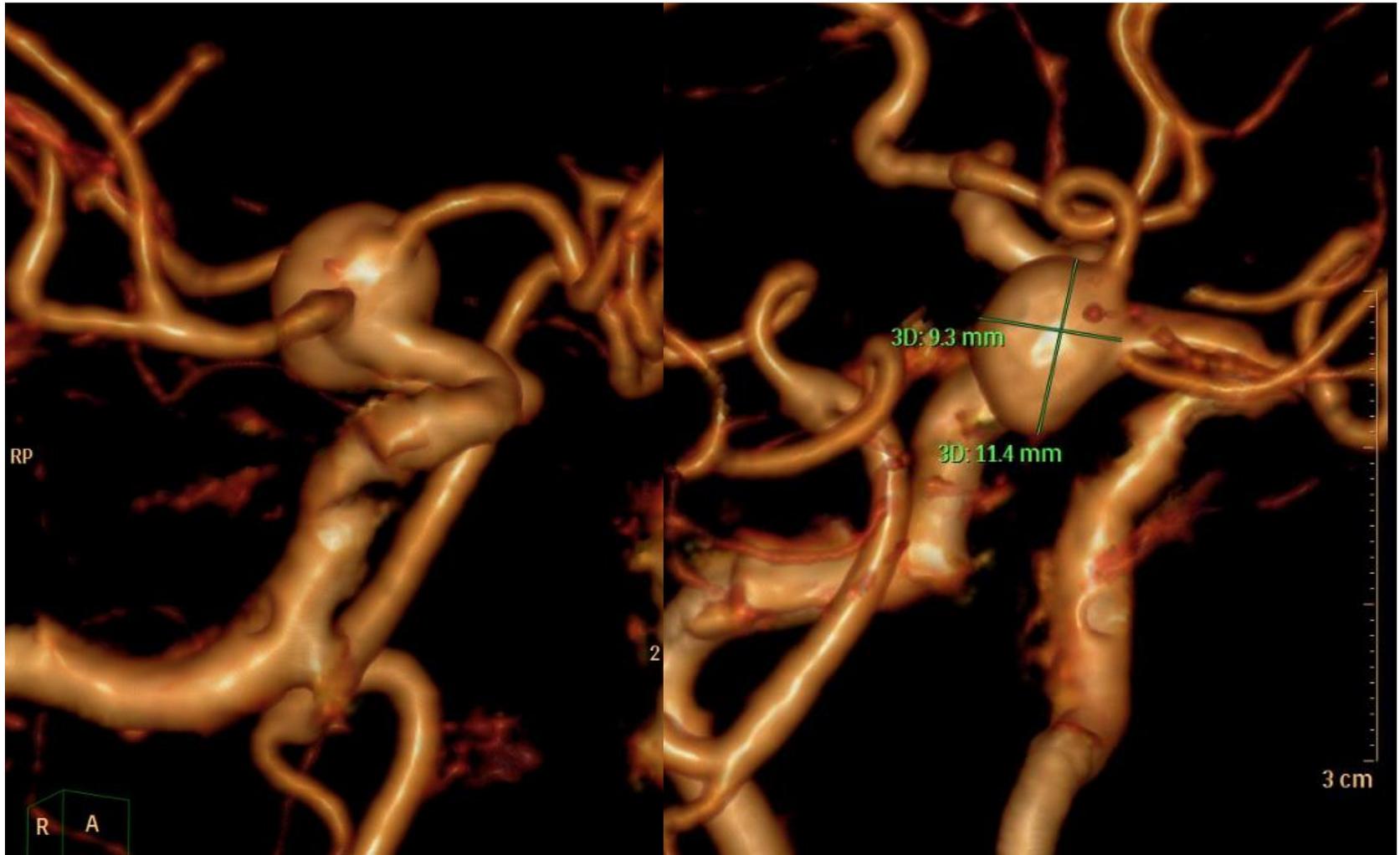
B.A. ♀, 57 a, CM Sn, proiezione superiore



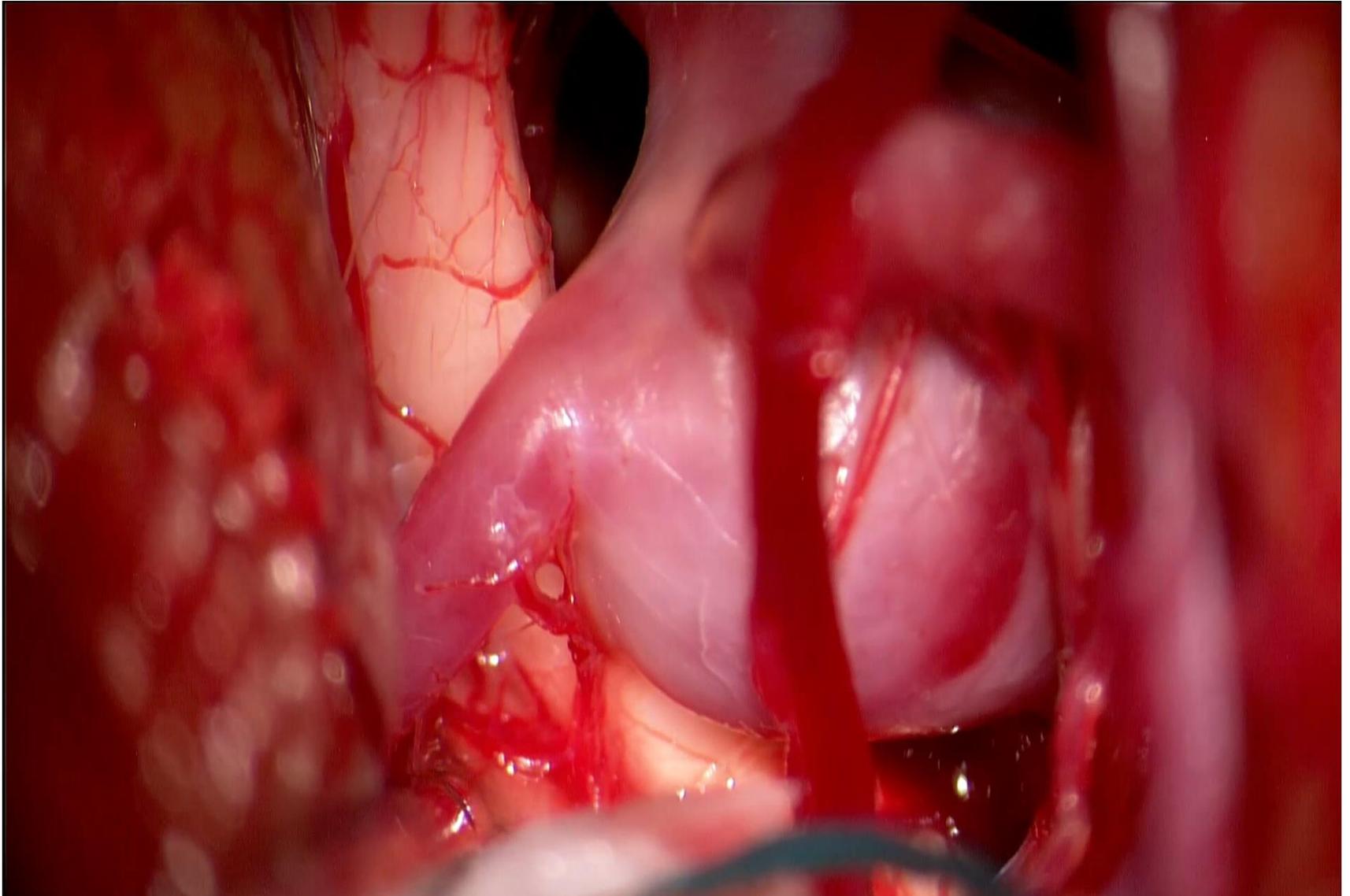
B.A. ♀, 57 a, CM Sn, proiezione superiore



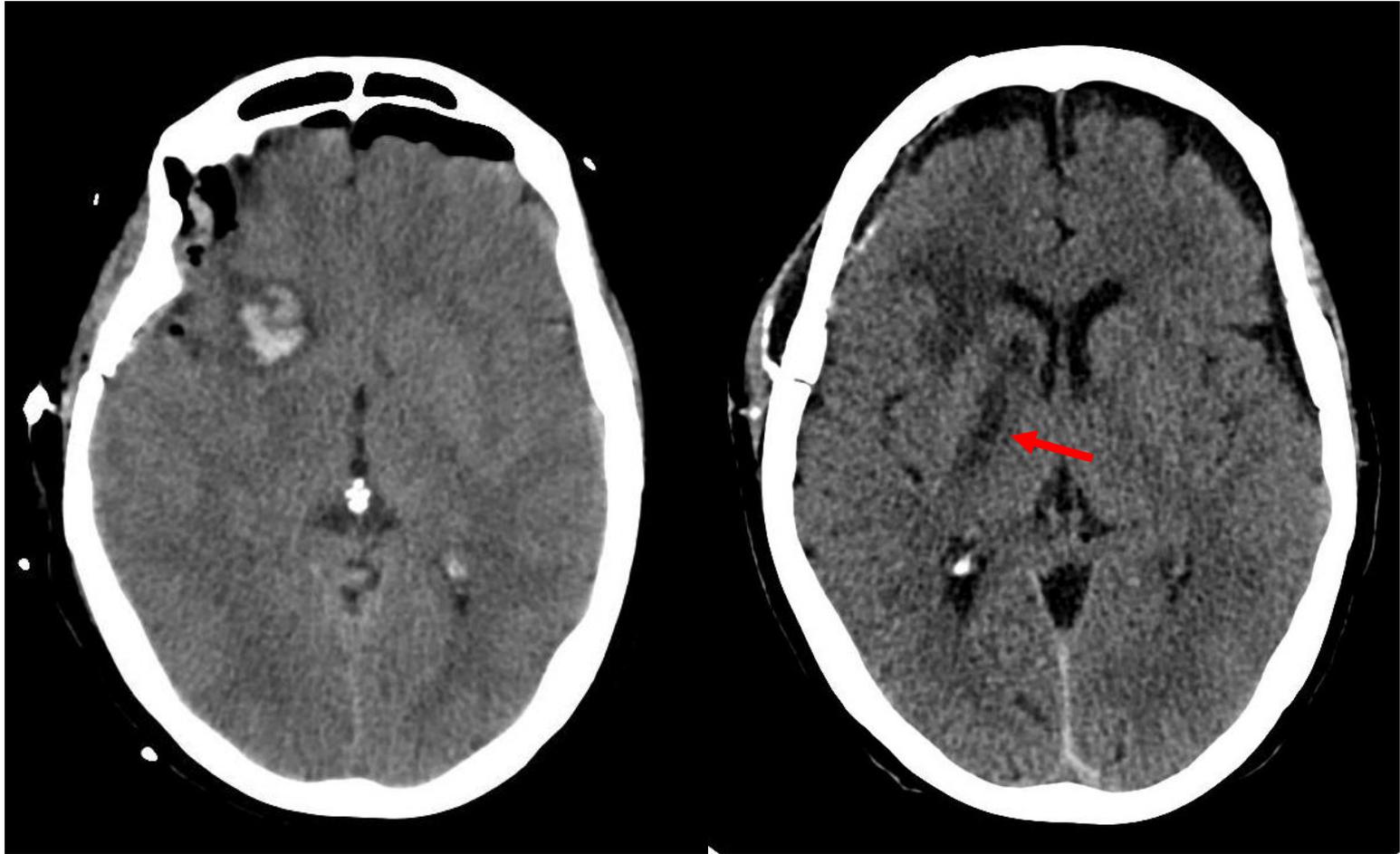
B.M. ♀, 70 a, biforcazione carotide Dx



B.M. ♀, 70 a, biforcazione carotide Dx



B.M. ♀, 70 a, biforcazione carotide Dx



# chirurgia - adjuncts

- clipping temporaneo
- flussimetria intraoperatoria  
(Charbel's ultrasound flow probe)

Temporary arterial occlusion in the repair of ruptured intracranial aneurysms: an analysis of risk factors for stroke

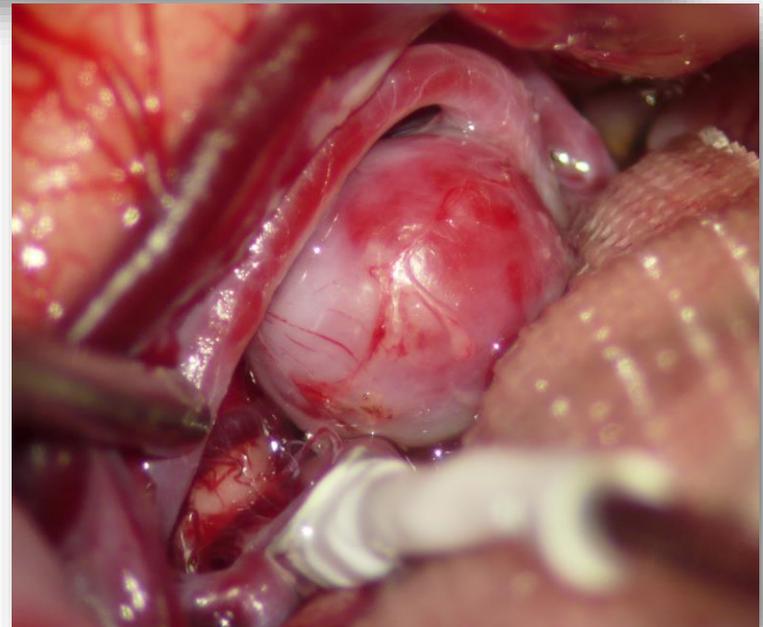
RICHARD FERCH, M.B.,B.S., F.R.A.C.S., ALBERTO PASQUALIN, M.D., GIAMPIETRO PINNA, M.D., FRANCO CHIOFFI, M.D., AND ALBINO BRICOLO, M.D.

*Department of Neurosurgery, University and City Hospital, Verona, Italy*

*Object.* This study was performed to further elucidate technical and patient-specific risk factors for perioperative stroke in patients undergoing temporary arterial occlusion during the surgical repair of their aneurysms.

*Methods.* One hundred twelve consecutive patients in whom temporary arterial occlusion was performed during surgical repair of an aneurysm were retrospectively analyzed. Confounding factors (inadvertent permanent vessel occlusion and retraction injury) were identified in six cases (5%) and these were excluded from further analysis. The demographics for the remaining 106 patients were analyzed with respect to age, neurological status, aneurysm characteristics, intraoperative rupture, duration of temporary occlusion, and number of occlusive episodes; end points considered were outcome at 3-month follow up and symptomatic and radiological stroke.

*Conclusions.* Overall 17% of patients experienced symptomatic stroke and 26% had radiological evidence of stroke attributable to temporary arterial occlusion. A longer duration of clip placement, older patient age, a poor clinical grade (Hunt and Hess Grades IV-V), early surgery, and the use of single prolonged clip placement rather than repeated shorter episodes were associated with a higher risk of stroke based on univariate analysis. Intraoperative aneurysm rupture did not affect stroke risk. On multivariate analysis, only poorer clinical grade ( $p = 0.001$ ) and increasing age ( $p = 0.04$ ) were significantly associated with symptomatic stroke risk.



# chirurgia - adjuncts

- monitoraggio neurofisiologico  
intraoperatorio (IOM)

Surgical and Electrophysiological Observations during Clipping  
of 134 Aneurysms with Evoked Potential Monitoring

Johannes Schramm, M.D., Antoun Koht, M.D., Gerhard Schmidt, Cand. Med., U. Pechstein, Cand. Med., M. Taniguchi, M.D.,  
and Rudolf Fahlbusch, M.D.

*Department of Neurosurgery, University of Erlangen-Nürnberg, Erlangen, Federal Republic of Germany*

- videoangiografia  
intraoperatoria - ICG



# temporary clipping: significant risk factors for stroke

## Temporary arterial occlusion in the repair of ruptured intracranial aneurysms: an analysis of risk factors for stroke

RICHARD FERCH, M.B.,B.S., F.R.A.C.S., ALBERTO PASQUALIN, M.D., GIAMPIETRO PINNA, M.D., FRANCO CHIOFFI, M.D., AND ALBINO BRICOLO, M.D.

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- age > 50 years
- Hunt-Hess grades IV-V
- temporary occlusion > 10 mins
- continuous occlusion

Results of univariate analysis of potential risk factors for poor outcome and stroke\*

Factor	No. of Patients	Good Outcome	Symptomatic	Stroke Type	
				Cortical	Perf Artery
age (yrs)					
<50	43	31 (73)	3 (7)	4 (9)	4 (10)
≥50	63	39 (62)	15 (24)	18 (29)	12 (19)
p value		NS	0.02	0.03	NS
Hunt & Hess Grade					
I–III	74	64 (86)	5 (7)	10 (13)	10 (13)
IV–V	32	6 (19)	13 (41)	12 (38)	6 (19)
p value		<0.001	<0.001	0.01	NS
Fisher Grade					
1–2	26	22 (85)	2 (9)	3 (12)	4 (14)
3–4	80	48 (60)	16 (20)	19 (24)	12 (15)
p value		0.04	NS	NS	NS
aneurysm size (mm)					
<15	78	52 (67)	10 (13)	13 (17)	12 (15)
≥15	28	18 (64)	8 (29)	9 (32)	4 (14)
p value		NS	NS	NS	NS
timing of surgery					
early	68	38 (56)	14 (21)	18 (26)	10 (15)
late	38	32 (83)	4 (11)	4 (11)	6 (16)
p value		0.006	NS	0.03	NS
intraop rupture					
none	61	38 (60)	11 (19)	14 (23)	7 (12)
rupture	45	32 (71)	7 (16)	8 (18)	9 (26)
p value		NS	NS	NS	NS
time of occlusion (mins)					
0–10	84	57 (68)	10 (12)	12 (14)	10 (12)
>10	22	13 (61)	8 (35)	10 (45)	6 (25)
p value		NS	0.01	0.007	NS

\* Early = Day 0 to 4 posthemorrhage; late = after Day 11 posthemorrhage; NS = not significant; perf = perforating.

# temporary clipping: intermittent vs continuous occlusion

TABLE 1

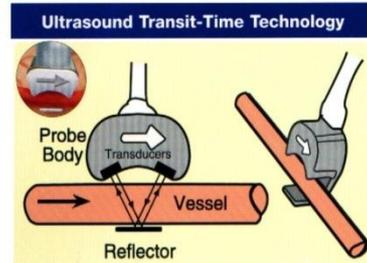
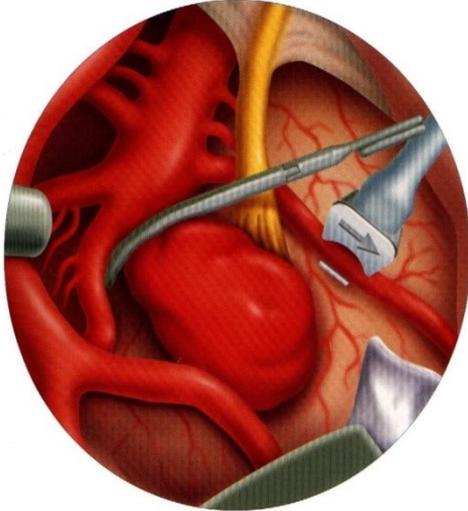
*Stratification of patients by type and time of occlusion*

Total Occlusion Time (mins)	No. of Patients (%)	
	Continuous	Intermittent
<5	44 (63)	6 (17)
5–10	14 (20)	19 (53)
11–20	10 (14)	9 (25)
>20	2 (3)	2 (6)

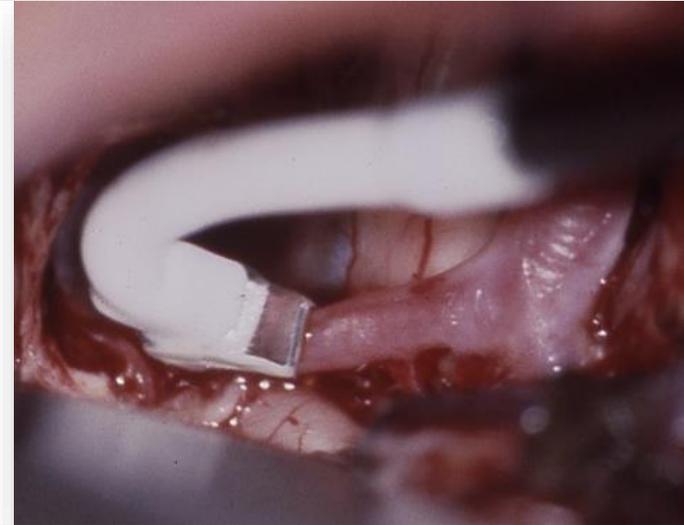
*Comparison of occlusion times in the incidence of symptomatic, cortical, and perforating vessel stroke with intermittent and continuous vessel occlusion*

Type of Occlusion	Occlusion Time (mins)	No. of Patients	Type of Stroke (%)		
			Symptomatic	Cortical	Perf Artery
continuous	<5	44	6 (14)	10 (23)	8 (18)
	5–10	14	3 (21)	3 (21)	2 (14)
	>10	12	4 (33)	4 (33)	2 (17)
intermittent	<5	6	0 (0)	1 (17)	0 (0)
	5–10	19	2 (11)	2 (11)	2 (11)
	>10	11	3 (27)	2 (18)	2 (18)

# transit time ultrasonic flow probe



**Volume Flow Measurement, not Velocity**  
 Using wide-beam illumination, two transducers pass ultrasonic signals back and forth, alternately intersecting flowing blood in upstream and downstream directions. The transit times of the ultrasonic beams are decreased when traveling downstream with blood flow and increased when traveling upstream against the flow. The difference between the integrated transit times is a measure of volume flow.



range (ml/min)      mean (ml/min)  $\pm$  SD

M1 tract

26  $\div$  63

39.2  $\pm$  16.0

M2 branches

7  $\div$  89

21.0  $\pm$  10.6

M3 (distal)

7  $\div$  45

13.5  $\pm$  5.6

valori di flusso basali (ml/min  $\pm$  DS) misurati in pazienti con aneurismi intatti e sanguinanti (2001-2010)

	Aneurismi intatti	Aneurismi sanguinanti
Tratto A1	30.9 $\pm$ 14.5	28.6 $\pm$ 10.9
Tratto A2	22.8 $\pm$ 10.3	24.7 $\pm$ 11.5
Tratto M1	39.2 $\pm$ 16.0	39.7 $\pm$ 14.5
Tratto M2	21.0 $\pm$ 10.6	21.7 $\pm$ 11.7
Tratto M3	13.5 $\pm$ 5.6	18.8 $\pm$ 11.0
ICA sopraclinoidea	42.0 $\pm$ 19.9	50.2 $\pm$ 23.0
A. pericallosa	14.9 $\pm$ 6.3	15.1 $\pm$ 4.6
PICA	12.2 $\pm$ 7.1	-

# Istituto di Neurochirurgia - Verona

aneurismi intracranici operati  
(1991 – 2016)

	N	%
sanguinanti	1376	78
 intatti	389	22
totale	1765	

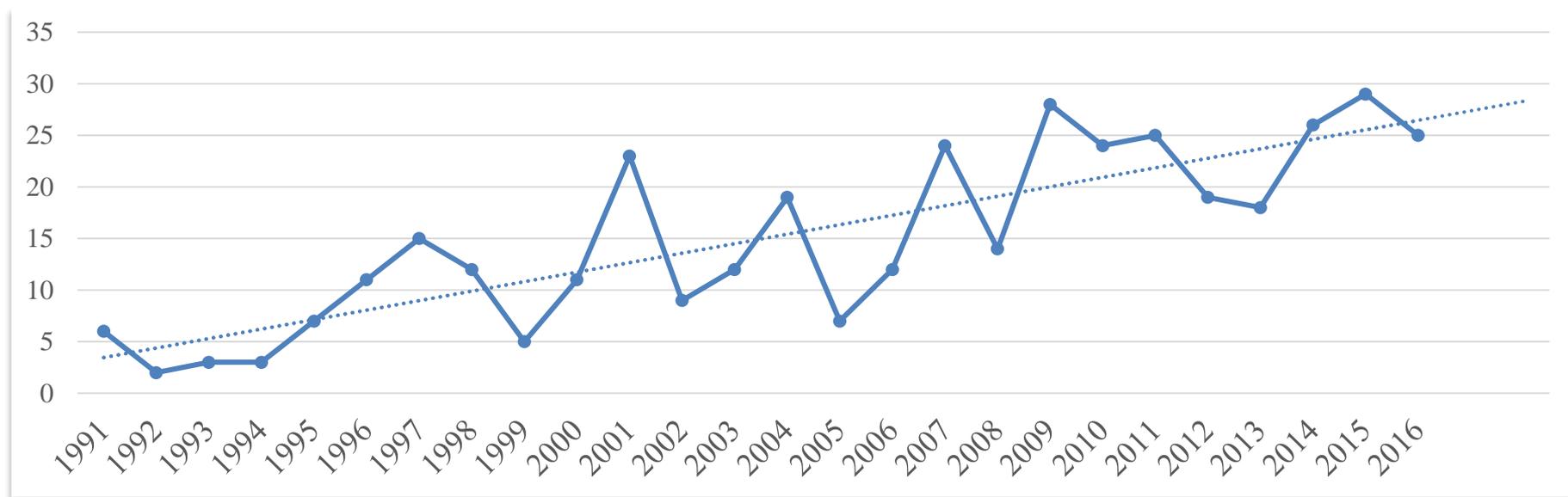
# Istituto di Neurochirurgia - Verona

aneurismi intatti operati  
(1991 – 2016)

- 389 pazienti operati
- maschi 111
- femmine 278 (71.4%)
- età media 56 anni (range: 17 – 78)

# Istituto di Neurochirurgia - Verona

aneurismi intatti operati  
(1991 – 2016)



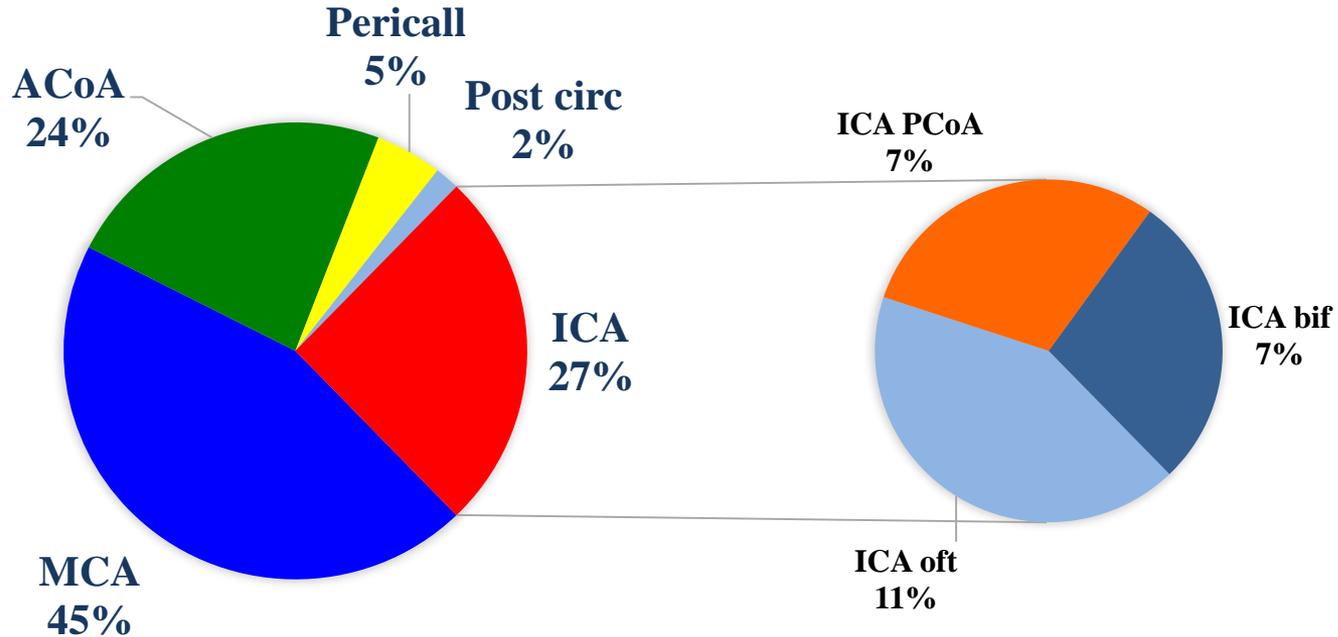
# Istituto di Neurochirurgia - Verona

aneurismi intatti operati (1991 – 2016)

- CCA: 95
- CM: 182
- CI: 104
  - C. Oftalmici: 44
  - CCP: 31
  - Biforcazione: 29
- Pericallosa: 19
- Circolo posteriore: 7

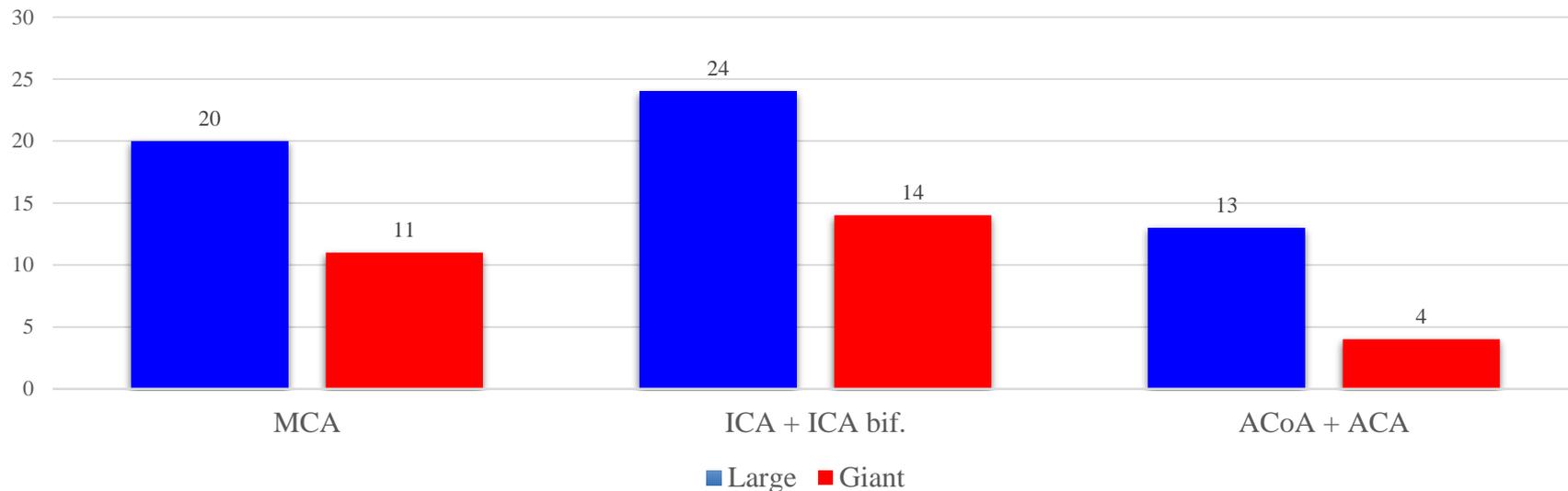
# Istituto di Neurochirurgia - Verona

## aneurismi intatti operati (1991 – 2016)



# Istituto di Neurochirurgia – Verona

## aneurismi intatti operati (1991 – 2016) – large/giant



	<b>Large</b>	<b>Giant</b>	<b>Total</b>
MCA	20	11	31
ICA + ICA bif.	24	14	38
ACoA + ACA	13	4	17
<b>Total</b>	<b>57</b>	<b>29</b>	<b>86</b>

# Istituto di Neurochirurgia - Verona

aneurismi intracranici operati  
(1991 – 2016)

	N	%	clipping temporaneo	%
sanguinanti	1376	78	292	21.2
intatti	389	22	167	43
totale	1765		459	



# aneurismi intatti operati (1991 – 2016)

## modalità di esclusione

	N	%
clipping	378	97
trapping/wrapping	11	3
tot	389	

# aneurismi intatti operati (1991 – 2016)

## grado di esclusione

	N	%
clipping	378	100
controllo angiografico post-operatorio disponibile	342	90.4
esclusione completa	331	97
esclusione incompleta	11*	3

\* successiva embolizzazione in 6 casi

# aneurismi intatti operati (1991 – 2016)

outcome



m Rankin score	N	%
0-2	365	93.8
3-5	22	5.7
D	2	0.5
Tot	389	-

## aneurismi complessi - trattamento

- tecniche chirurgiche particolari
  - by-pass
- modalità di trattamento combinata (chirurgico/endovascolare)

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# HIGH-FLOW BYPASS GRAFTS IN THE MANAGEMENT OF COMPLEX INTRACRANIAL ANEURYSMS

THE MAJORITY OF intracranial aneurysms can be treated by either endovascular coiling or microsurgical clipping. A small group of aneurysms may require vascular bypass or reconstruction for their management. A variety of vascular reconstruction techniques are available, including direct suture, patch grafting, local reimplantations, side to side anastomosis, and bypass grafts. Bypass grafts may include low-flow (superficial temporal to middle cerebral) and high-flow bypass grafts (radial artery to middle cerebral or anterior tibial to anterior tibial). In this article, the indications and techniques for high-flow bypass grafting are discussed. Seven intraoperative videos have been included to illustrate techniques of radial artery graft harvesting, cervical artery reconstruction, and concurrent aneurysm management.

**KEY WORDS:** Cerebral aneurysms, High-flow grafts, Radial artery

*Neurosurgery 60[ONS Suppl 1]:ONS-105–ONS-123, 2007*

Delaying the treatment of the aneurysm to a later time after grafting may be problematic in two ways: 1) because of the increased intra-aneurysmal pressure, the aneurysm may rupture while waiting and 2) because the flow continues in the parent vessel, the graft may clot off. Because of these issues, we prefer to treat the aneurysm immediately once we are convinced that there is good flow through the graft.

Mohit, Sekhar et al, Neurosurgery 60: ONS 105 (2007)

# BYPASS SURGERY FOR COMPLEX BRAIN ANEURYSMS: AN ASSESSMENT OF INTRACRANIAL-INTRACRANIAL BYPASS

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**OBJECTIVE:** Bypass surgery for brain aneurysms is evolving from extracranial-intracranial (EC-IC) to intracranial-intracranial (IC-IC) bypasses that reanastomose parent arteries, revascularize efferent branches with in situ donor arteries or reimplantation, and reconstruct bifurcated anatomy with grafts that are entirely intracranial. We compared results with these newer IC-IC bypasses to conventional EC-IC bypasses.

**METHODS:** During a 10-year period, 82 patients underwent bypass surgery as part of their aneurysm management. A quarter of the patients presented with ruptured aneurysms and two-thirds presented with compressive symptoms from unruptured aneurysms. Most aneurysms (82%) had non-saccular morphology and 56% were giant sized. Common locations included the cavernous internal carotid artery (23%), middle cerebral artery (20%), and posteroinferior cerebellar artery (12%).

**RESULTS:** Forty-seven patients (57%) received EC-IC bypasses and 35 patients (43%) received IC-IC bypasses, including 9 in situ bypasses, 6 reimplantations, 11 reanastomoses, and 9 intracranial grafts. Aneurysm obliteration rates were comparable in EC-IC and IC-IC bypass groups (97.9% and 97.1%, respectively), as were bypass patency rates (94% and 89%, respectively). Three patients died (surgical mortality, 3.7%), and 4 patients were permanently worse as a result of bypass occlusions (neurological morbidity, 4.9%). At late follow-up (mean duration, 41 months), good outcomes (Glasgow Outcome Scale score 5 or 4) were measured in 68 patients (90%) overall, and were similar in EC-IC and IC-IC bypass groups (91% and 89%, respectively). Changes in Glasgow Outcome Scale score were slightly more favorable with IC-IC bypass (6% worse or dead after IC-IC bypass versus 14% with EC-IC bypass).

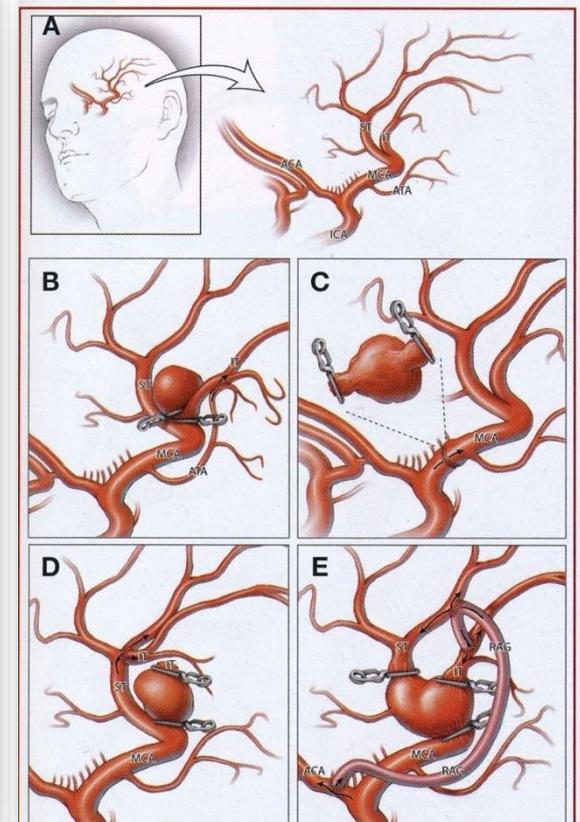
**CONCLUSION:** IC-IC bypasses compare favorably to EC-IC bypasses in terms of aneurysm obliteration rates, bypass patency rates, and neurological outcomes. IC-IC bypasses can be more technically challenging to perform, but they do not require harvest of extracranial donor arteries, spare patients a neck incision, shorten interposition grafts, are protected inside the cranium, use caliber-matched donor and recipient arteries, and are not associated with ischemic complications during temporary arterial occlusions. IC-IC bypass can replace conventional EC-IC bypass with more anatomic reconstructions for selected aneurysms involving the middle cerebral artery, posteroinferior cerebellar artery, anterior cerebral artery, and basilar apex.

**KEY WORDS:** Aneurysm, Clipping, Extracranial-to-intracranial bypass, In situ bypass, Intracranial-to-intracranial bypass, Reanastomosis, Reimplantation, Revascularization

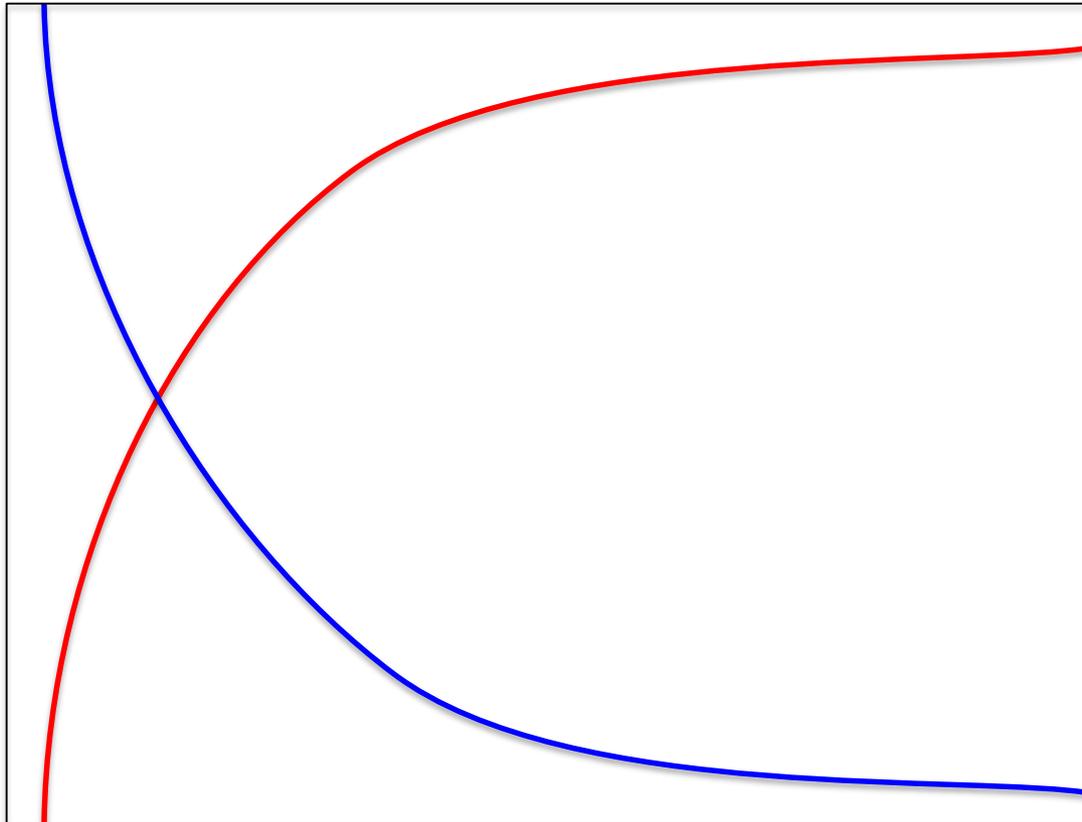
*Neurosurgery* 65:670-683, 2009

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# aneurysm surgery



challenging  
aneurysms



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# AHA/ASA Guideline

## Guidelines for the Management of Patients With Unruptured Intracranial Aneurysms

### A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

#### Surgical Clipping: Recommendations

1. Several factors, including patient age and aneurysm location and size, should be taken into account when considering surgical clipping as the mode of treatment for a UIA (*Class I; Level of Evidence B*).
2. Imaging after surgical intervention, to document aneurysm obliteration, is recommended given the differential risk of growth and hemorrhage for completely versus incompletely obliterated aneurysms (*Class I; Level of Evidence B*).
3. Long-term follow-up imaging may be considered after surgical clipping given the combined risk of aneurysm recurrence and de novo aneurysm formation. Long-term follow-up may be particularly important for those aneurysms that are incompletely obliterated during initial treatment (*Class IIb; Level of Evidence B*).
4. Surgical treatment of UIA is recommended to be performed at higher-volume centers (eg, performing >20 cases annually) (*Class I; Level of Evidence B*).
5. The use of specialized intraoperative tools and techniques for avoiding vessel compromise or residual aneurysms may be considered to reduce the adverse outcomes seen with operative management of UIAs (*Class IIb; Level of Evidence C*).

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sts.

Surgeons, the Congress  
Interventional Surgery

Stroke 46, 2368-2400, 2015

# conclusioni - 1

- rischio di rottura degli aneurismi intatti: molteplici dati con diversi livelli di evidenza, non generalizzabili
- presente: valutazione del rischio di trattamento con molteplici parametri clinico-radiologici
- mancano modelli accurati in grado di predire l'efficacia e il rischio di complicazioni del trattamento preventivo
- risultati migliori in centri “high volume”

## conclusioni - 2

- futuro: migliore comprensione della fisiopatologia della formazione e della rottura degli aneurismi
- miglioramento dei tools diagnostici (MR ad alto campo): individuazione di aree di instabilità nella parete degli aneurismi
- ruolo emergente dei fenomeni infiammatori; prevenzione della rottura?

