Surgical treatment of cerebral AVMs

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Incidence of AVMs

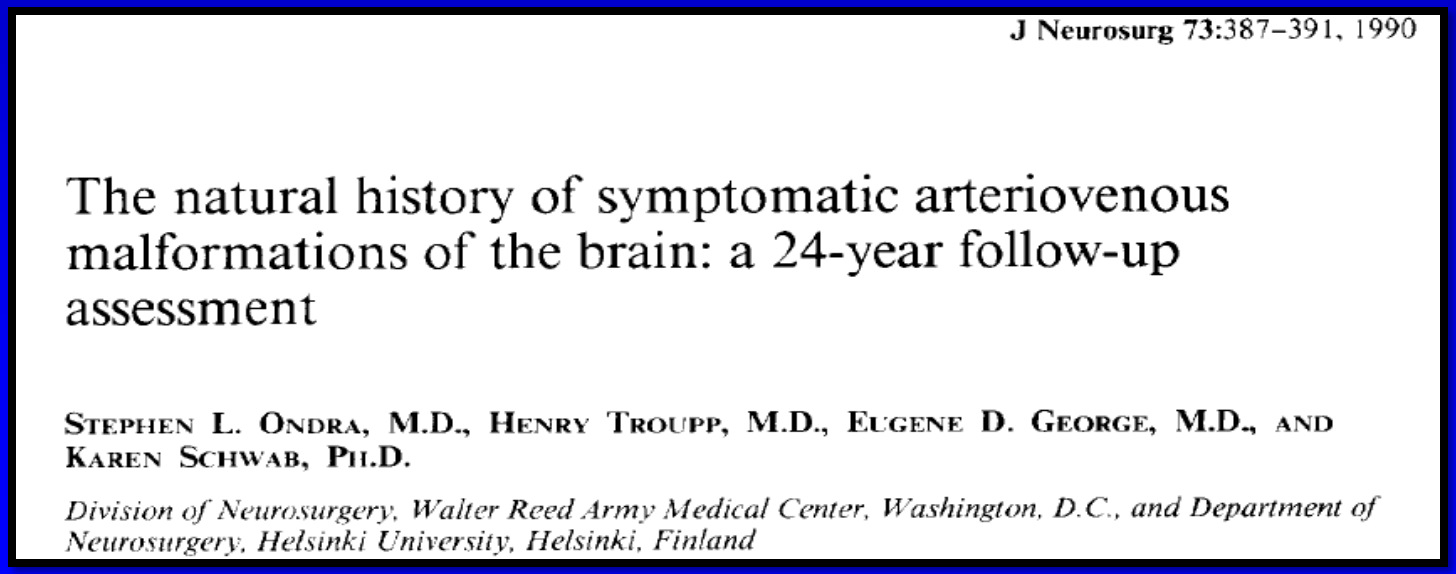
- ARUBA incidence 0.9/100,000
- Czech Republic
  - Around 100 new AVMs /year
- AVM : aneurysms 1:10

Symptoms of AVM

- ICH
- SAH
- Epilepsy
- Hemiparesis
- Headache
- Murmur
- Incidental AVM

Natural course of AVM (Ondra, Troupp 1990)

Rupture of AVM causes:
25 % death
42% permanent morbidity
33% survival without a deficit



J Neurosurg 73:387–391, 1990

The natural history of symptomatic arteriovenous malformations of the brain: a 24-year follow-up assessment

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Natural History of Brain Arteriovenous Malformations: A Long-term Follow-up Study of Risk of Hemorrhage in 238 Patients

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OBJECTIVE: Long-term follow-up studies in patients with brain arteriovenous malformations (AVM) have yielded contradictory results regarding both risk factors for rupture and annual rupture rate. We performed a long-term follow-up study in an unselected, consecutive patient population with AVMs admitted to the Department of Neurosurgery at Helsinki University Central Hospital between 1942 and 2005.

METHODS: Patients with untreated AVMs were followed from admission until death, occurrence of AVM rupture, initiation of treatment, or until the end of 2005. Patients with at least 1 month of follow-up were included in further analysis. Annual and cumulative incidence rates of AVM rupture as well as several potential risk factors for rupture were analyzed using Kaplan-Meier life table analyses and Cox proportional hazards regression models.

RESULTS: We identified 238 patients with a mean follow-up period of 13.5 years (range, 1 month–53.1 years). The average annual risk of hemorrhage from AVMs was 2.4%. The risk was highest during the first 5 years after diagnosis, decreasing thereafter. Risk factors predicting subsequent AVM hemorrhage in univariate analysis were young age, previous rupture, deep and infratentorial locations, and exclusively deep venous drainage. Previous rupture, large AVM size, and infratentorial and deep locations were independent risk factors according to multivariate models.

CONCLUSION: According to this long-term follow-up study, AVMs with previous rupture and large size, as well as with infratentorial and deep locations have the highest risk of subsequent hemorrhage. This risk is highest during the first few years after diagnosis but remains significant for decades.

KEY WORDS: Arteriovenous malformation, Cerebrovascular, Intracerebral hemorrhage, Stroke, Subarachnoid hemorrhage

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Diagnostics

- CT + CTA
- DSA
- MRI
- fMRI, tractography

Spetzler – Martin grading scale

Microsurgical resection

-Based on ***Spetzler-Martin*** grading system estimating the risk of surgery, which consists of three elements: size, venous drainage, and location.

Characteristic	Number Points Assigned
Size of lesion:	
Small (<3 cm.)	1 Point
Medium (3-6 cm.)	2 Points
Large (>6 cm.)	3 Points
Location:	
Non-eloquent site	0 Points
Eloquent site*	1 Point
Pattern of venous drainage:	
Superficial only	0 Points
Any deep	1 Point

*Sensorimotor, language, or visual cortex, hypothalamus or thalamus; internal capsule; brain stem; cerebellar peduncles; or cerebellar nuclei

Based on Spetzler RF, Martin NA. A proposed grading system for arteriovenous malformations.J Neurosurg. 1986 Oct;65(4):476-83

Spetzler-Martin Grading	Points	Supplementary Grading
Size, cm		Age, y
<3	1	<20
3-6	2	20-40
>6	3	>40
Venous drainage		Bleeding
Superficial	0	Yes
Deep	1	No
Eloquence		Compactness
No	0	Yes
Yes	1	No
Total	5	

Supplementary Spetzler-Martin Grading System

Neurosurgery. 2015 Jan;76(1):25-31; discussion 31-2; quiz 32-3. doi: 10.1227/NEU.0000000000000556.

Validation of the supplemented Spetzler-Martin grading system for brain arteriovenous malformations in a multicenter cohort of 1009 surgical patients.

Kim H[1], Abla AA, Nelson J, McCulloch CE, Bervini D, Morgan MK, Stapleton C, Walcott BP, Ogilvy CS, Spetzler RF, Lawton MT.

ETHODS:

Data collected from 1009 AVM patients who underwent AVM resection were used to compare the predictive powers of SM and SM-Supp grades. Patients included the original 300 University of California, San Francisco patients plus those treated thereafter (n = 117) and an additional 592 patients from 3 other centers.

RESULTS:

In the combined cohort, the SM-Supp system performed better than SM system alone: area under the receiver-operating characteristics curve (AUROC) = 0.75 (95% confidence interval, 0.71-0.78) for SM-Supp and AUROC = 0.69 (95% confidence interval, 0.65-0.73) for SM (P < .001). Stratified analysis fitting models within 3 different follow-up groupings (<6 months, 6 months-2 years, and >2 years) demonstrated that the SM-Supp system performed better than SM system for both medium (AUROC = 0.71 vs 0.62; P = .003) and long (AUROC = 0.69 vs 0.58; P = .001) follow-up. **Patients with SM-Supp grades ≤6 had acceptably low surgical risks (0%-24%), with a significant increase in risk for grades >6 (39%-63%).**

CONCLUSION:

This study validates the predictive accuracy of the SM-Supp system in a multicenter cohort. An SM-Supp grade of 6 is a cutoff or boundary for AVM operability. Supplemented grading is currently the best method of estimating neurological outcomes after AVM surgery, and we recommend it as a starting point in the evaluation of AVM operability.

Simplified classification of AVMs

A 3-tier classification of cerebral arteriovenous malformations, J Neurosurg, 2011

Robert F. Spetzler, M.D., and

Francisco A. Ponce, M.D.

ClassA: SM I-II

Class B: SM III

Class C: SM IV-V

Spetzler – Martin grading scale - treatment

Most of neurosurgical centres:

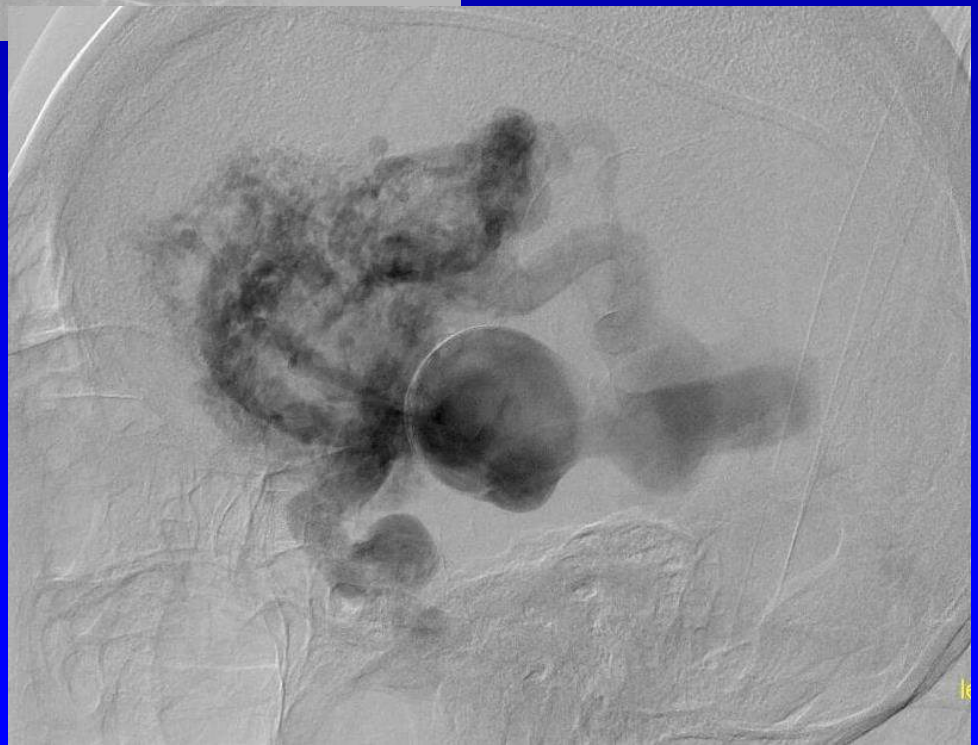
- SM I.-III. – microneurosurgery
- SM IV.-V. – another

Treatment modalities

- Microneurosurgery
- Embolisation (coils, ONYX)
- Radiosurgery (2-3 years to obliteration)
  - Gamma knife
  - LINAC
- Combination (microneurosurgery + embolisation + radiosurgery)

- Conservative treatment

Male 36 years, repeated ICH, SM V, conservative tr.



The choice of treatment modality

- Symptomatology and its severity
- Age, neurological deficit, overall status
- SM grade, flow through AVM, AVM related aneurysms
- Intracerebral hematoma, hydrocephalus
- Availability, limits and knowledge of treatment results of each modality

Surgery for AVM

- Preoperative planning
  - MRI (extremely important for planning the approach)
    - Localisation of AVM
    - Localisation of eloquent areas
    - Localisation of feeders and veins
  - DSA

Surgery for AVM

- Positioning, head above heart
- Larger craniotomy
- Careful dura opening
- Identification of feeders
  - Superficial (ICG)
  - Deep
- Identification and sparing of the draining veins

Surgery for AVM

- „Relaxed“ brain – mannitol, anesthesia
- Microscope
- Minimal brain retraction
- Precise manipulation with neurovascular structures
- Proximal controle of arterial feeders with temporary clips
- Dissection around the nidus
- Finally coagulation and interruption of the draining veins
- Thorough hemostasis

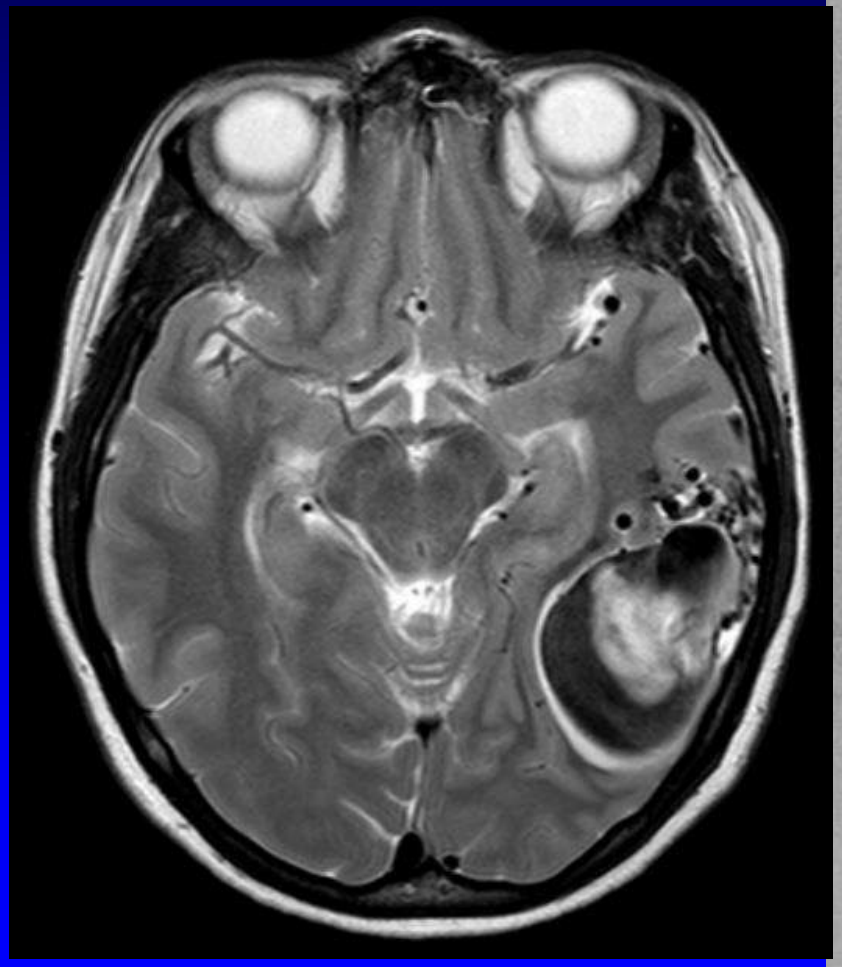
Thorough hemostasis

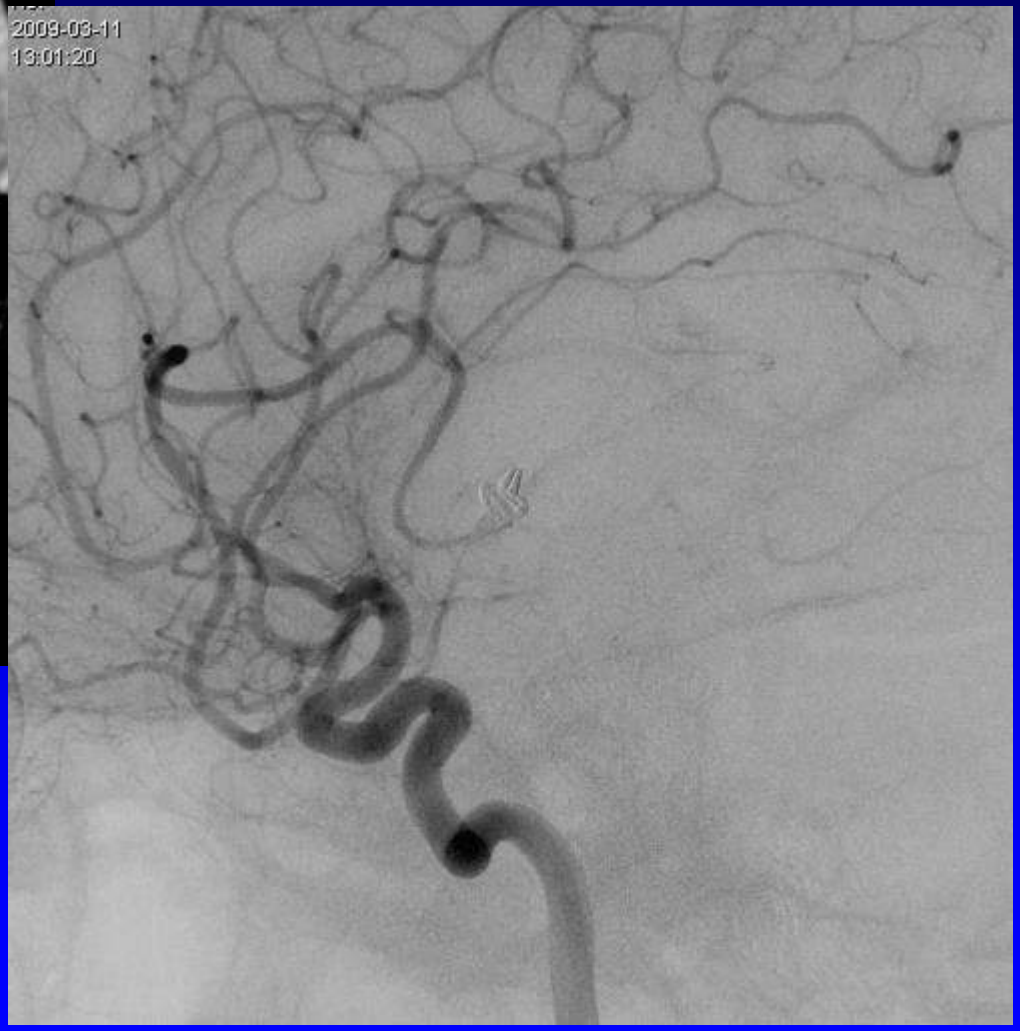
If there is a problem with hemostasis after the AVM resection, usually there is a residual of AVM left behind !

Postoperative care

- Normotension
- Normovolemia
- Antiepileptic drugs
- Sedation
- Imaging – CT, DSA ….

Female 35 years, epilepsy and alexia, SM IV, good result

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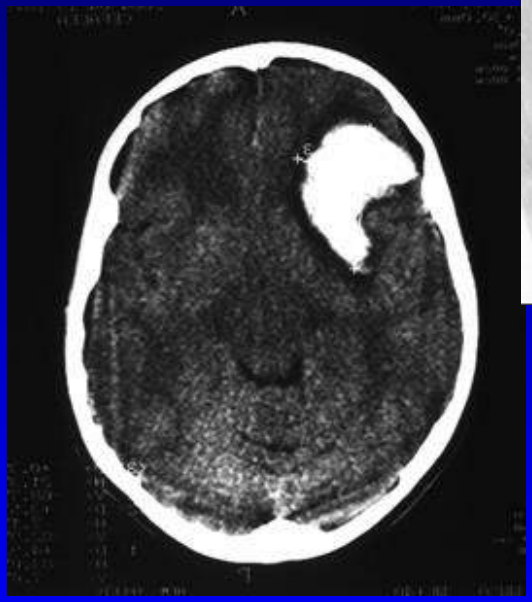


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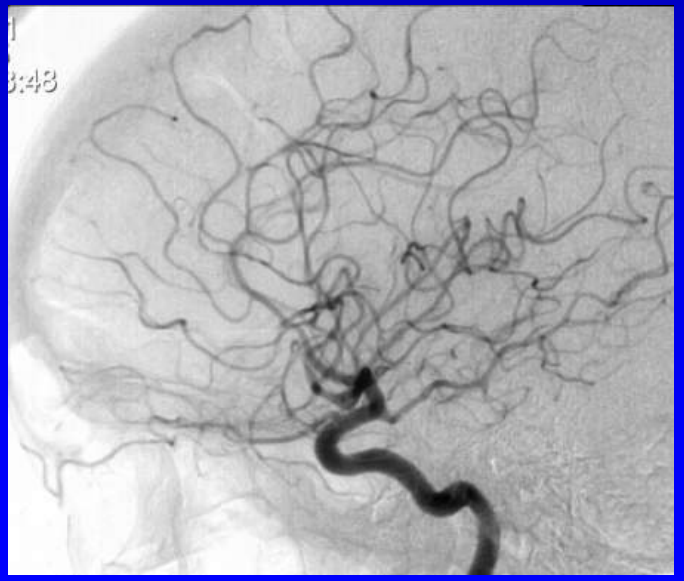
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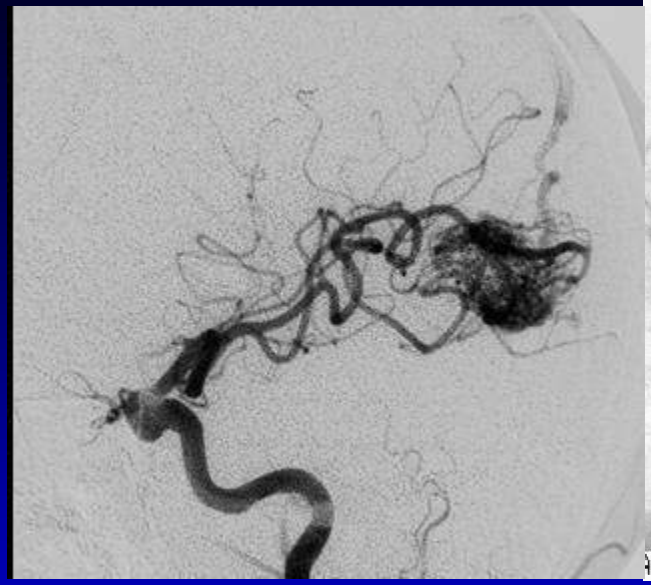

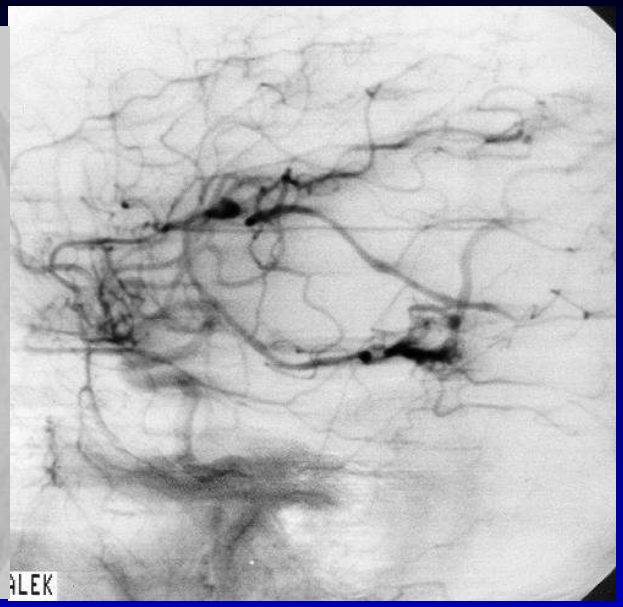


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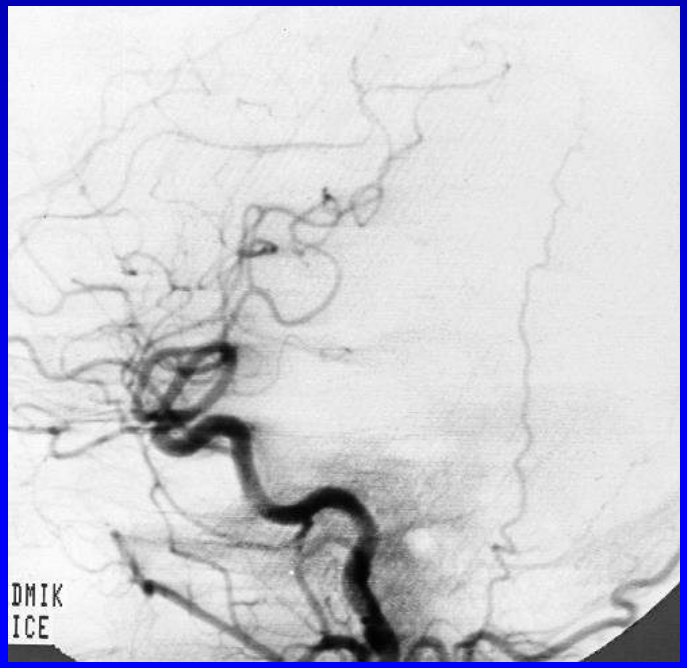
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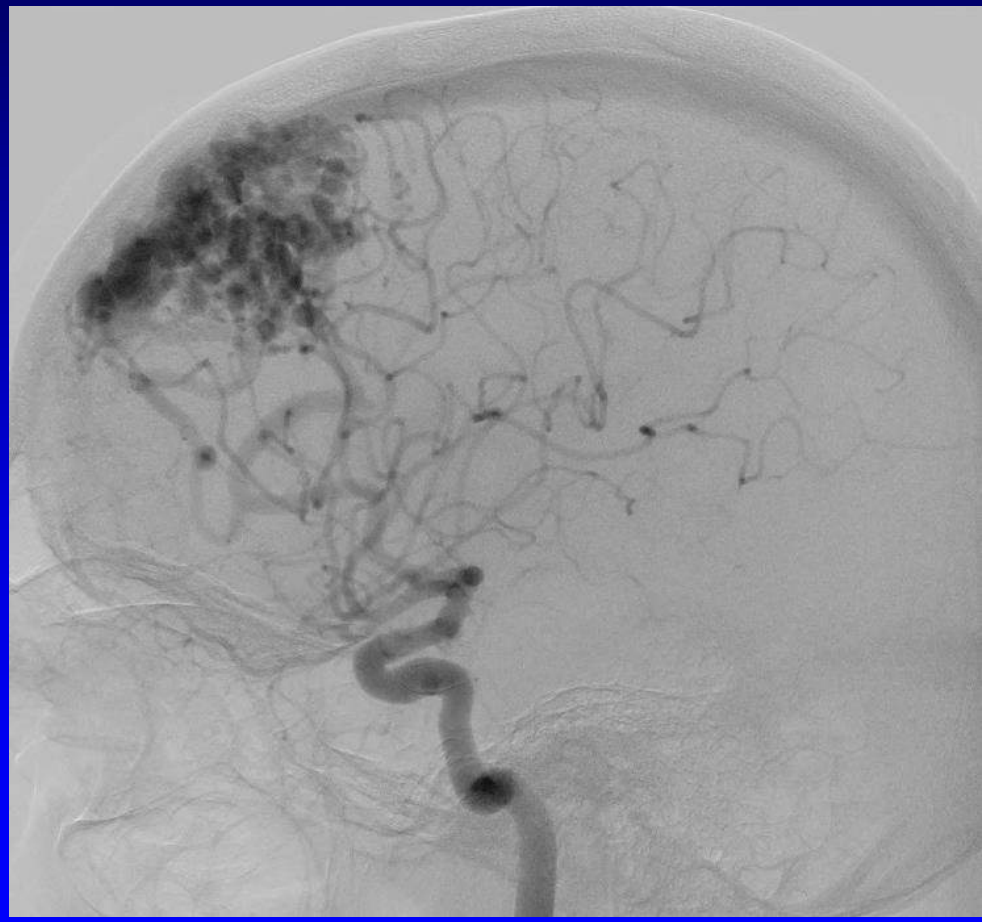
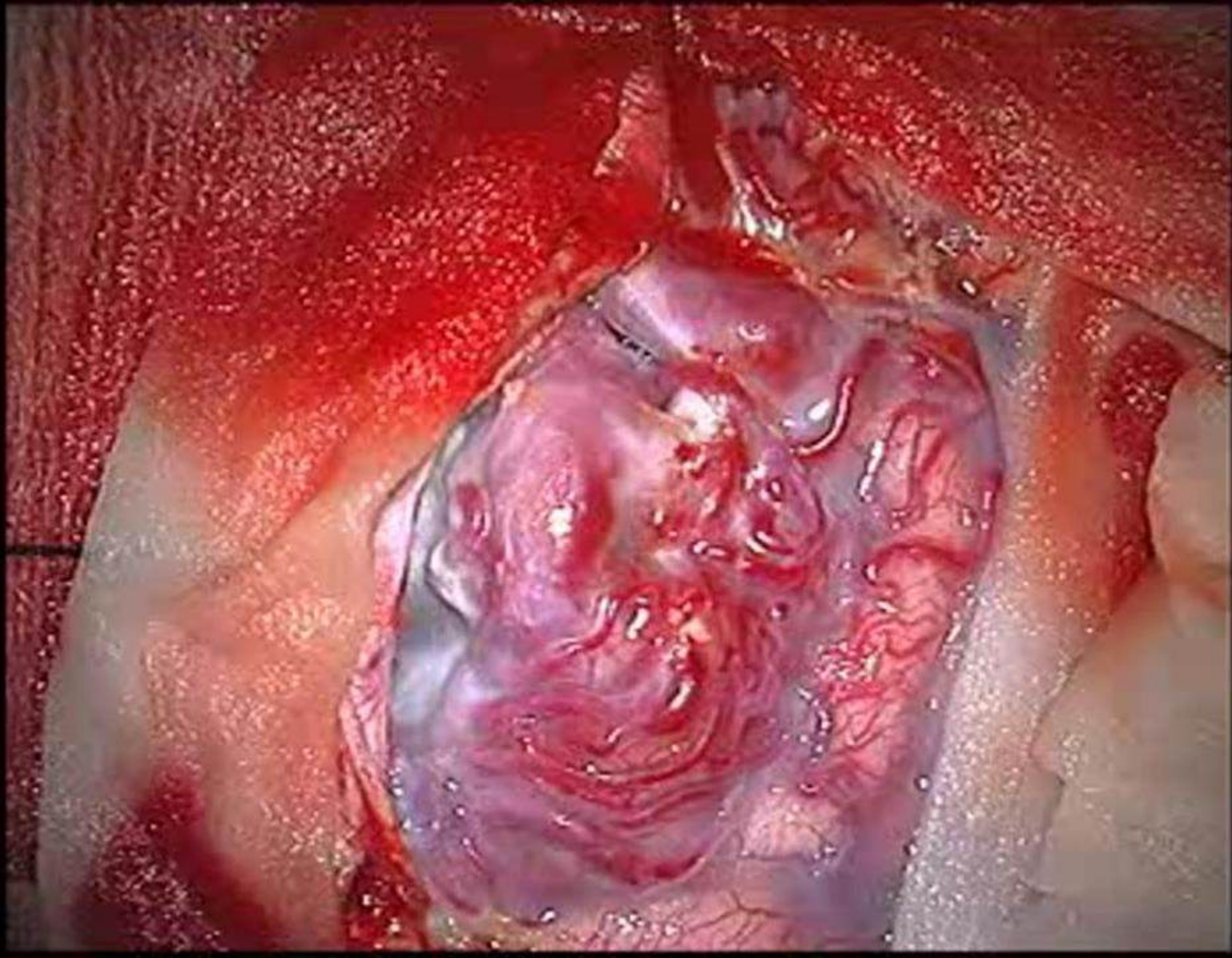
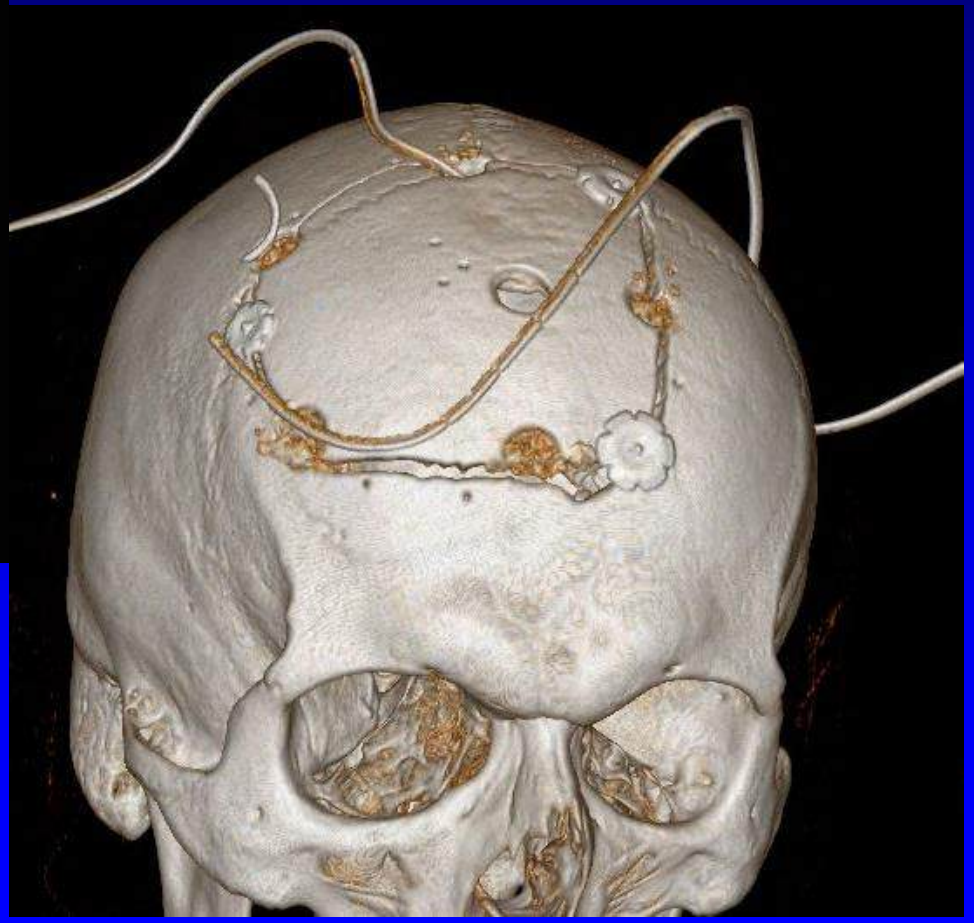
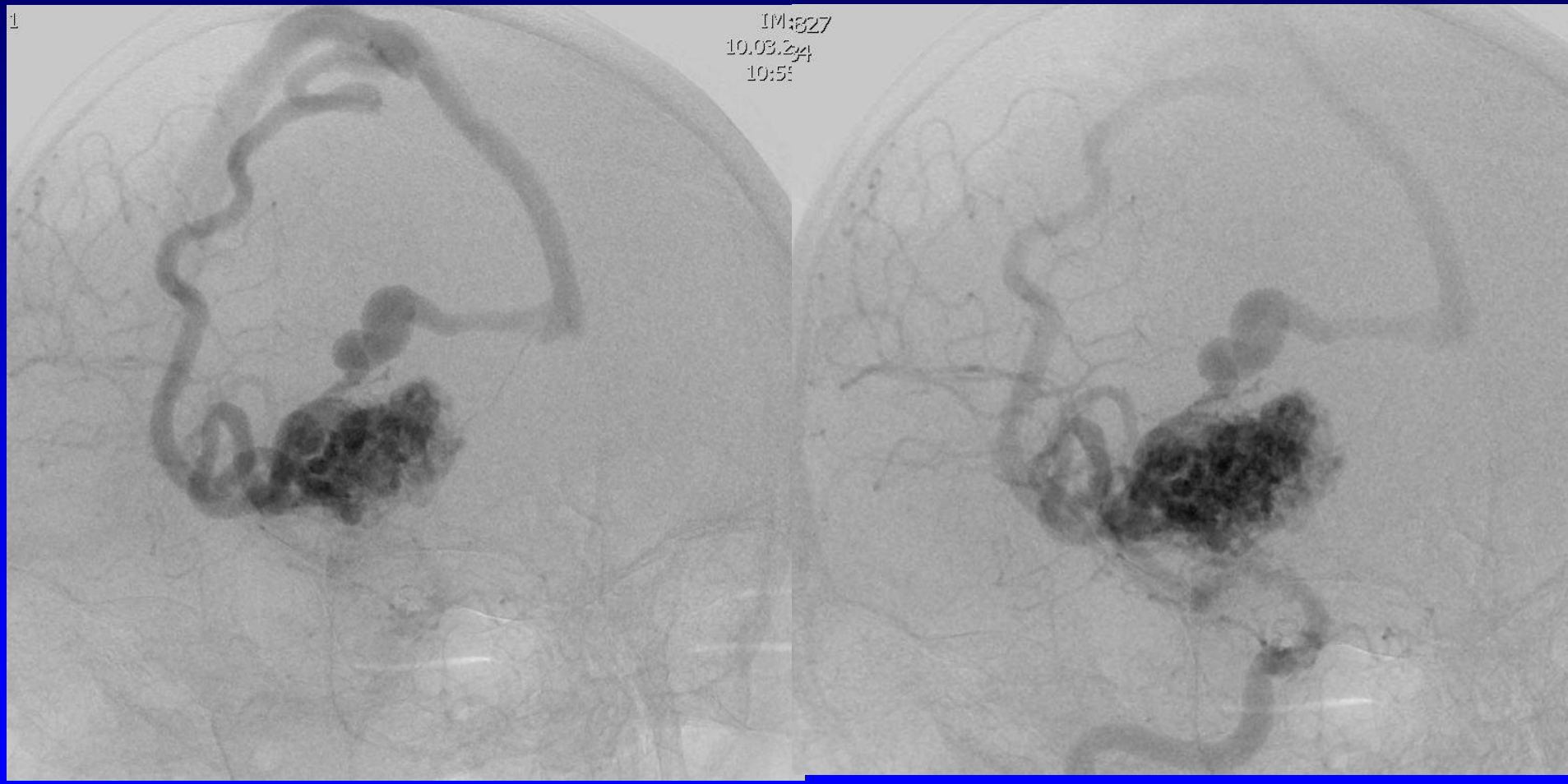
Male 21 years, epilepsy, SM II, good result

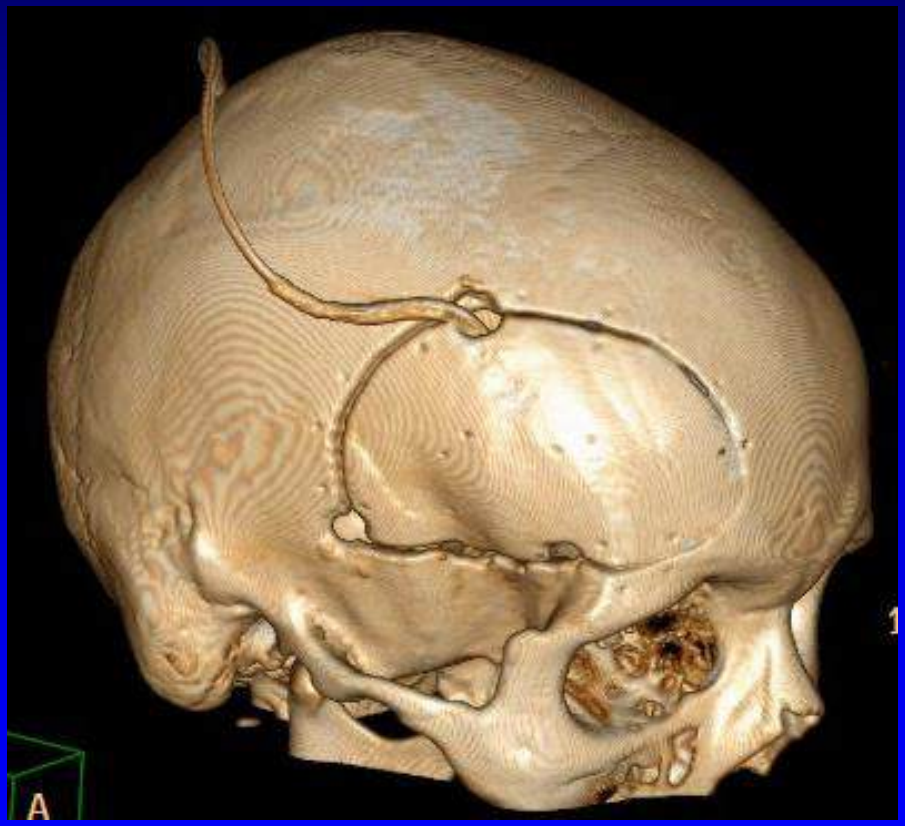






Male 23 years, epilepsy, SM II, good result

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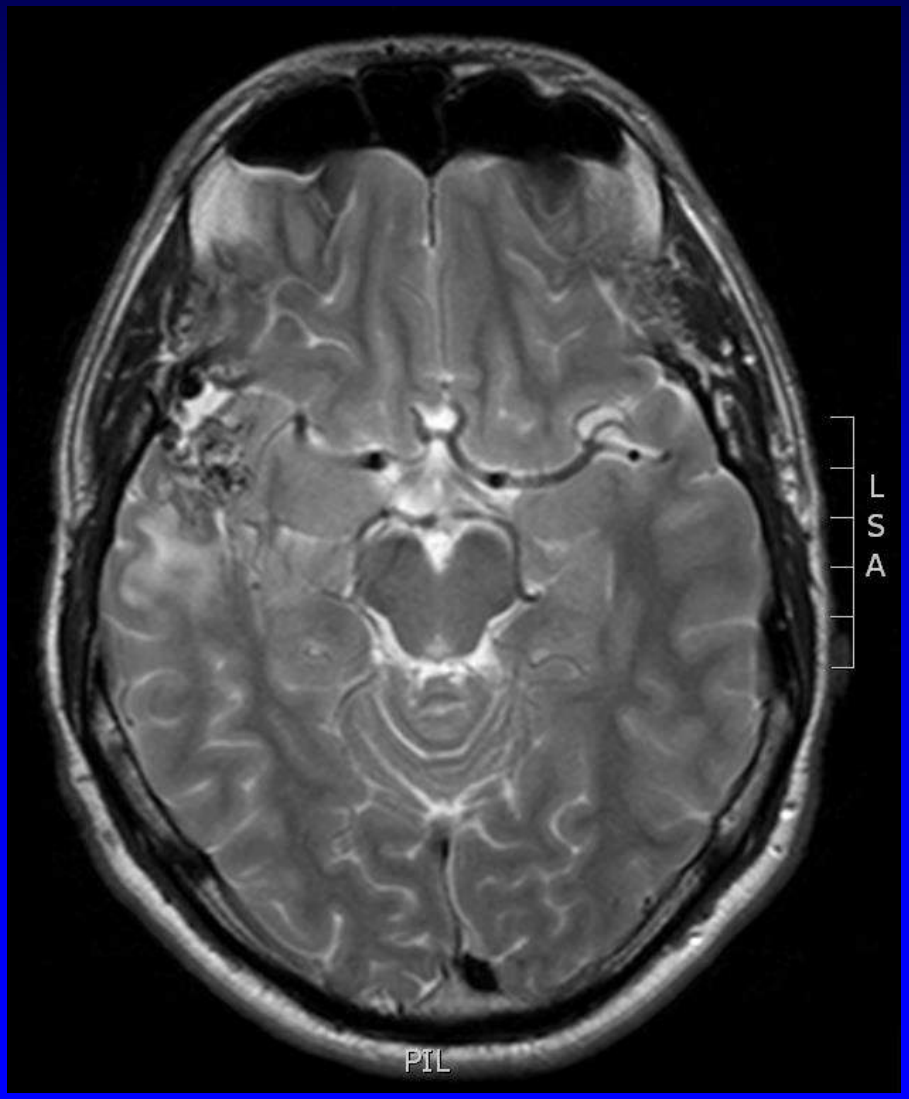
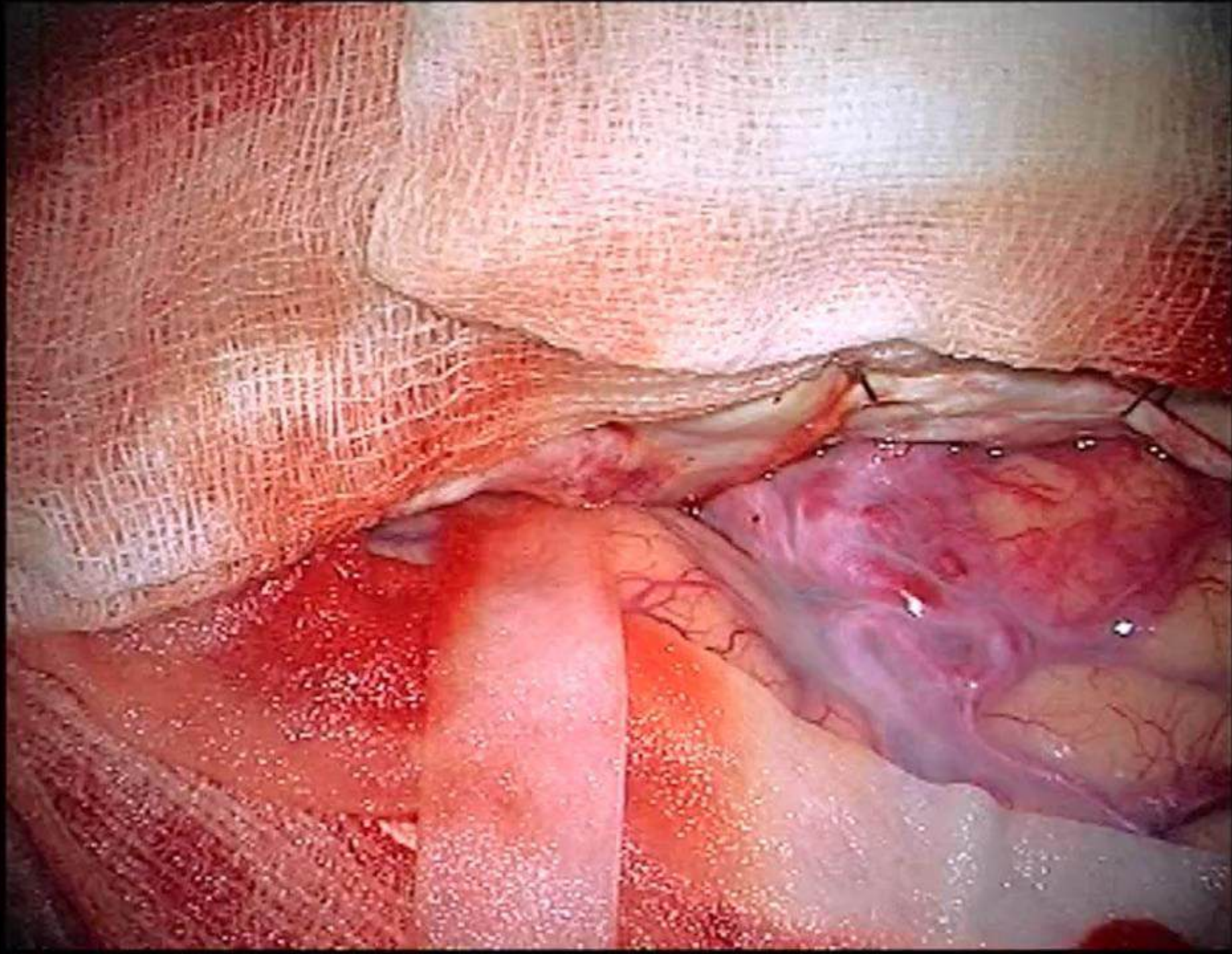
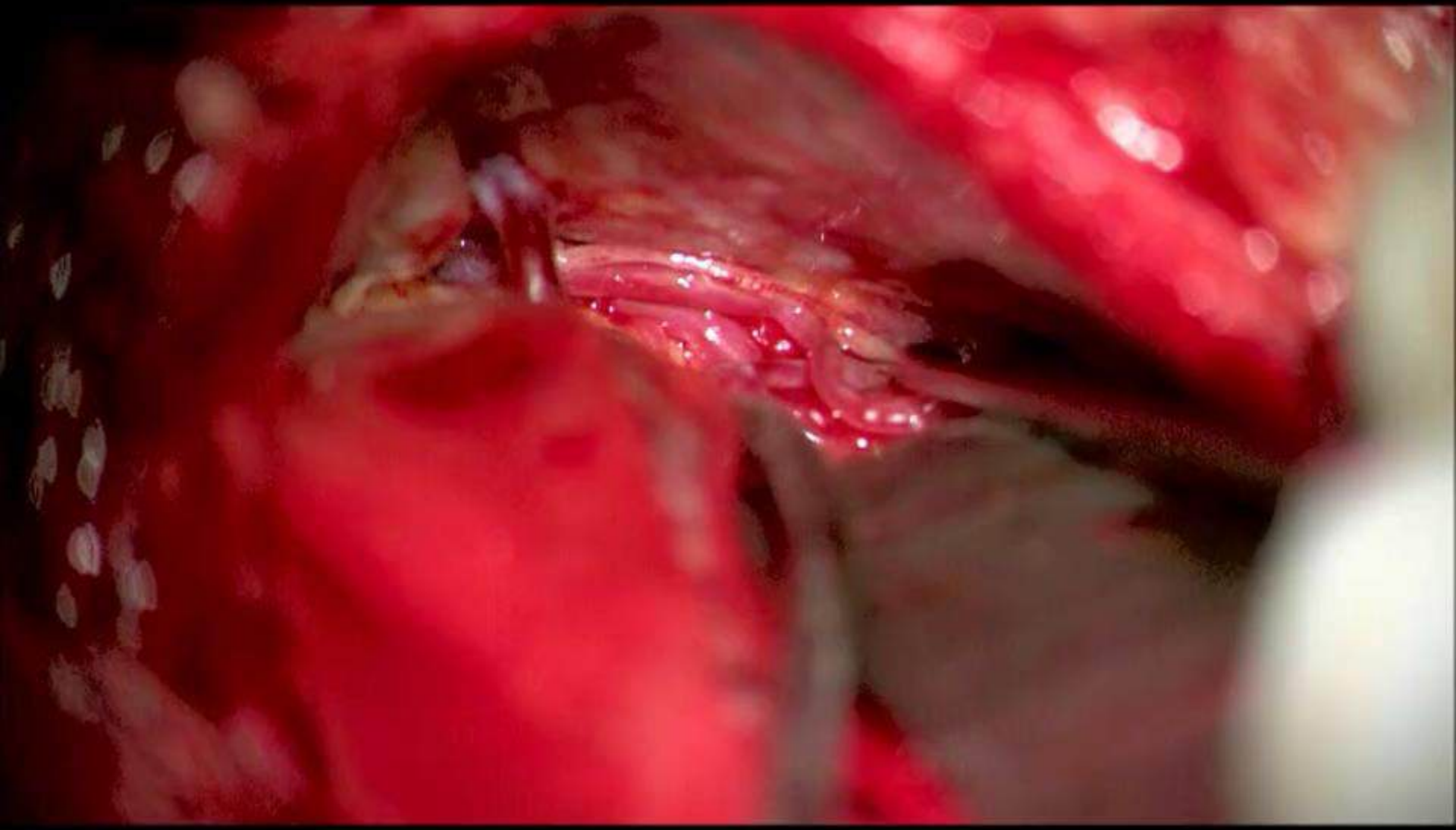
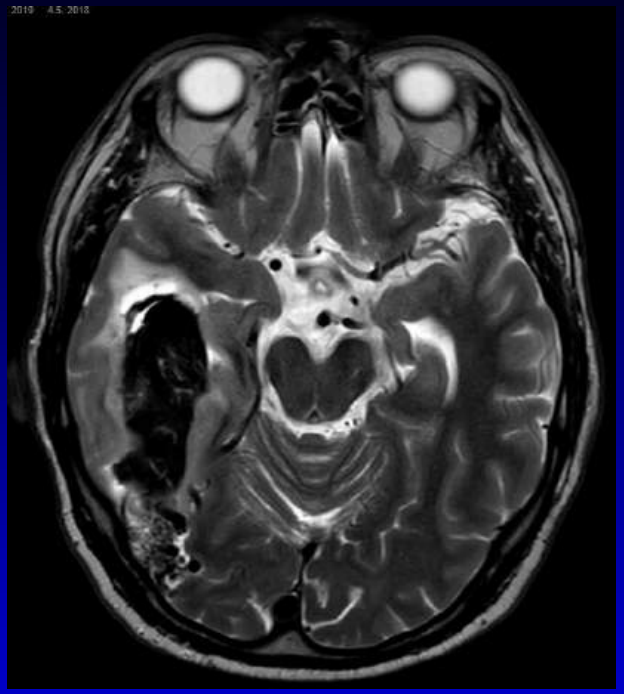
Male, 37 years, one grand mal, SM II, good result







AVM reg T-O l.dx.



Poděkování doc.plk.F.Charvátovi, Ph.D.

Surgical results - AVM (2005-2021)

- 55 pial AVMs

- Average age 39,2 (13-70 let), 30 male, 25 female

- Presentation of AVM:

  Headache 5

  Bleeding 27

  Epilepsy 16

  Incidental 7

Location - 47 supratentorial, 8 infratentorial

- Spetzler Martin grading:

  I: 14

  II: 32

  III: 8

  IV: 1

Surgical results - AVM (2005-2021)

- Total resection 53, subtotal 1, 1 AVM not found during surgery – very small
- 48 good recovery
- 6 moderate disability (1x cognitive deficit, 2x mild hemiparesis, 2x as a result of primary bleeding), 2x visual disturbance - location

  1 severe disability (as a result of primary bleeding)
- Mortality 0%

Conclusion

- The aim is a total resection of AVM
- Most SM I a II should be operated
- Most SM III should be operated (sometimes combined treatment)
- Radiosurgery – small and deep AVMs, older patients
- Embolisation usually as a part of combined treatment in higher grades (III a IV)
- SM V: usually conservative treatment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