Complicated Brain Arteriovenous Malformation (AVM) with Radiation Necrosis

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- **Demographics:** Male; 24 years
- **Pre-radiosurgery Presentation:** Headache for 2 years before radiosurgery treatment
- **Diagnosis:** Medium size brain AVM
- **Pre-radiosurgery Treatment:** None
- **Radiosurgery Treatment:**
  Upfront (primary); Linac-based stereotactic radiosurgery (SRS) for left temporal, medium size AVM
- **Radiosurgery Dosimetry:**
  - Target volume: 2.9 cc
  - Marginal dose: 18.0 Gy
  - Marginal isodose: 80%
  - Maximum dose: 41.3 Gy
  - Minimum dose: 8.1 Gy
  - Average dose: 23.8 Gy
  - Number of isocenters: 2
  - Maximum dose to brain stem: 13.7 Gy
- **Follow-Up Period:** 36 months post-SRS
- **Clinical Outcome:**
  - 6 months post-SRS: Stationary headache
  - 12 months post-SRS:
    Increased headache
    Started medications (steroids, diuretics)
  - 17 months post-SRS:
    Improving headache with medications
    Developed memory deficits
    Experienced partial seizures with secondary generalization
    Added more medications (steroids, diuretics, anticonvulsants)
  - 18 months post-SRS:
    More improvement of headache
    Stationary memory deficits
    Improving generalized seizures with medications
    Continued medications (steroids, diuretics, anticonvulsants)
  - 18 months post-SRS:
    Improved headache
    Improving, with residual, memory deficits
    Improving, with residual, generalized seizures
    Continued medications (steroids, diuretics, anticonvulsants)
  - 20 months post-SRS:
    Stationary improved headache
    Stationary residual memory deficits
    Stationary residual generalized seizures
    Continued medications (steroids, diuretics, anticonvulsants)
    Newly developed bilateral visual field defects (right homonymous hemianopia)
  - 24 months post-SRS:
    Stationary improvement of headache
    Stationary residual memory deficits
    Improving seizures control with medications
    Continued medications (steroids, diuretics, anticonvulsants)
    Stationary bilateral visual field defects (right homonymous hemianopia)
  - 30 months post-SRS:
    Stationary improvement of headache
    Stationary residual memory deficits
    Partial control of seizures with medications
    Continued anticonvulsant medications and gradual tapering of steroids and diuretics
    Stationary bilateral visual field defects (right homonymous hemianopia)
  - 36 months post-SRS:
    Sustainable improvement of headache
    Stationary residual memory deficits
    Stationary partial control of seizures with medications

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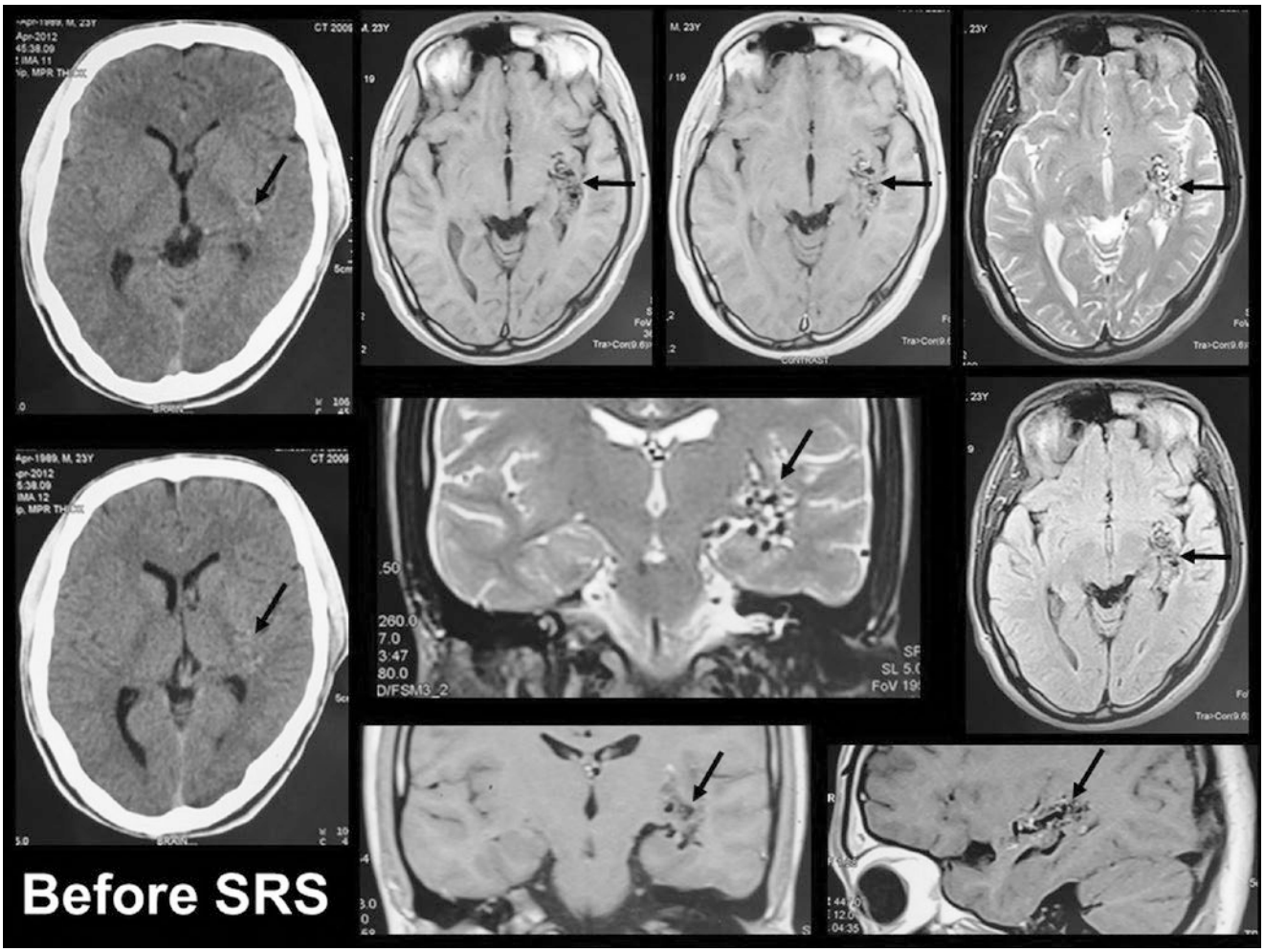
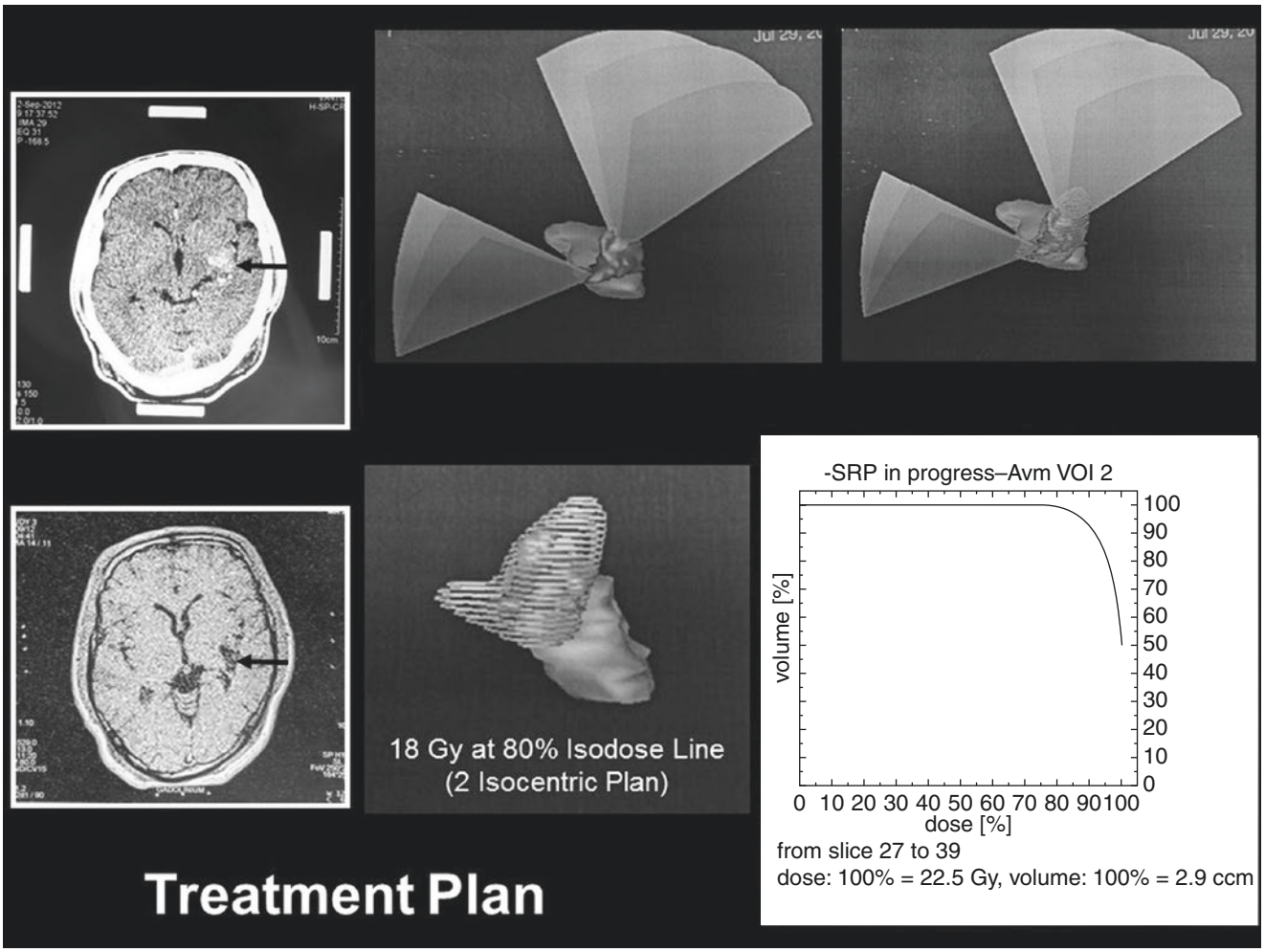
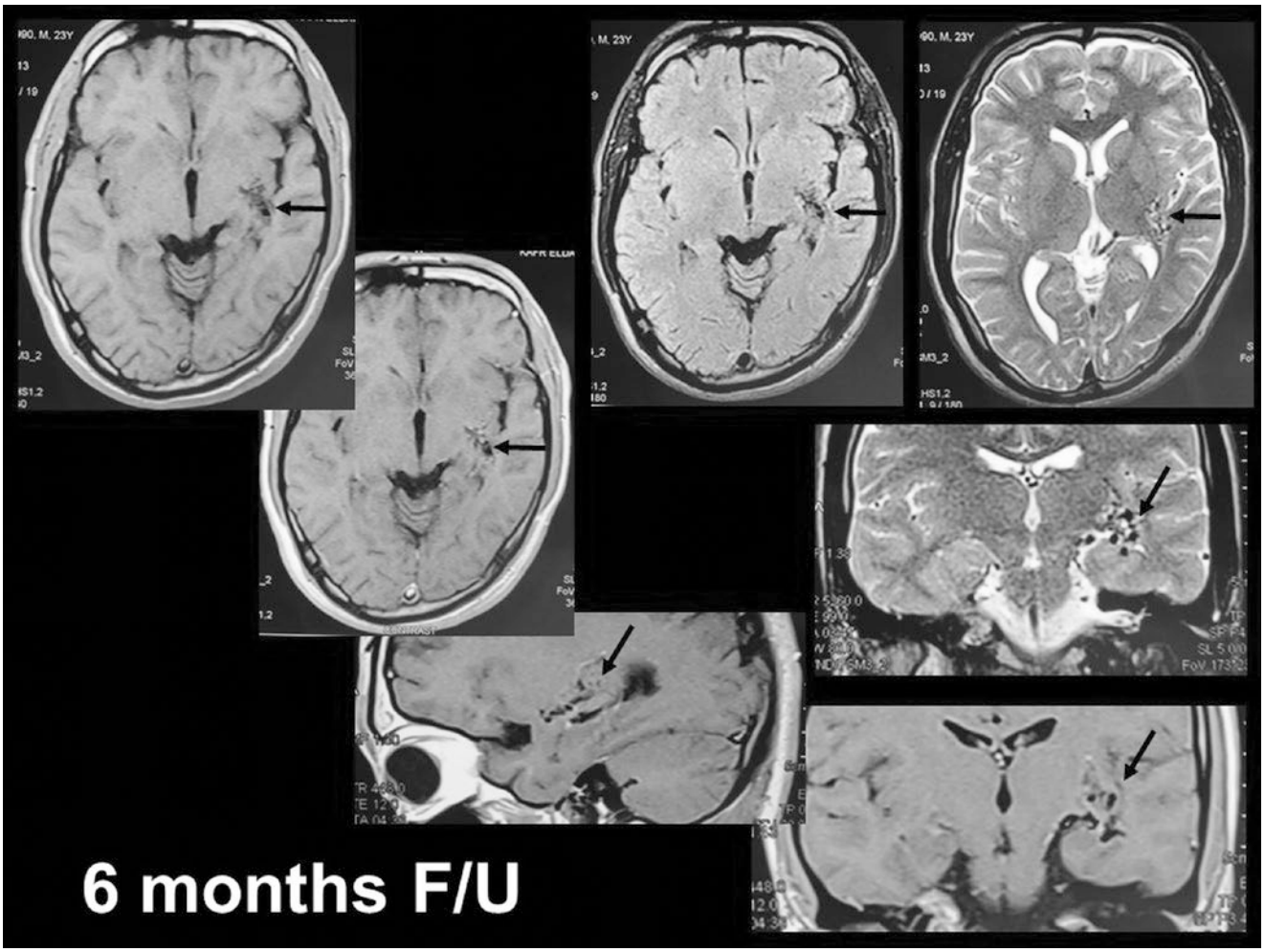
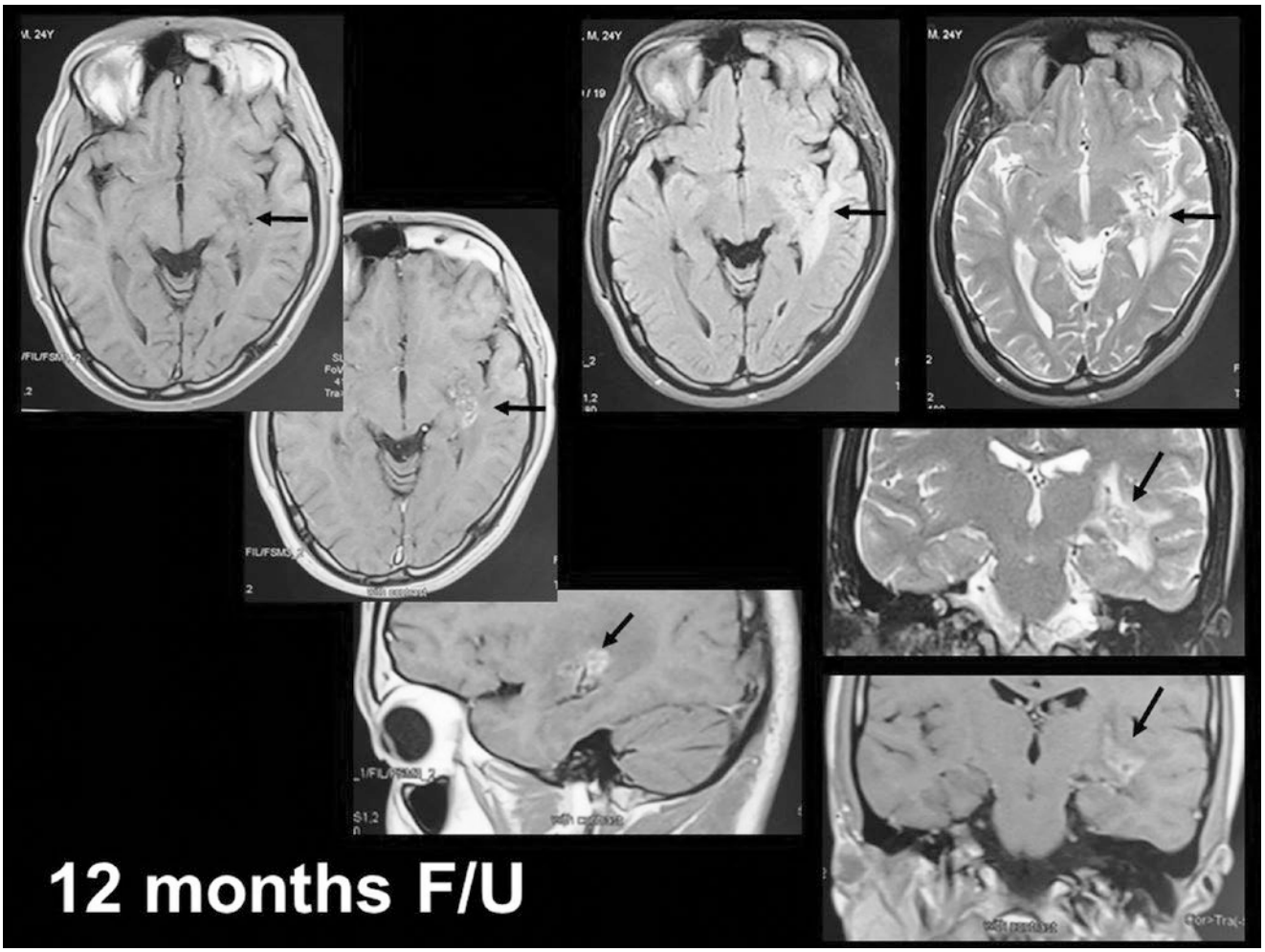
Continued anticonvulsant medications and stopped steroids and diuretics
Permanent bilateral visual field defects (right homonymous hemianopia)

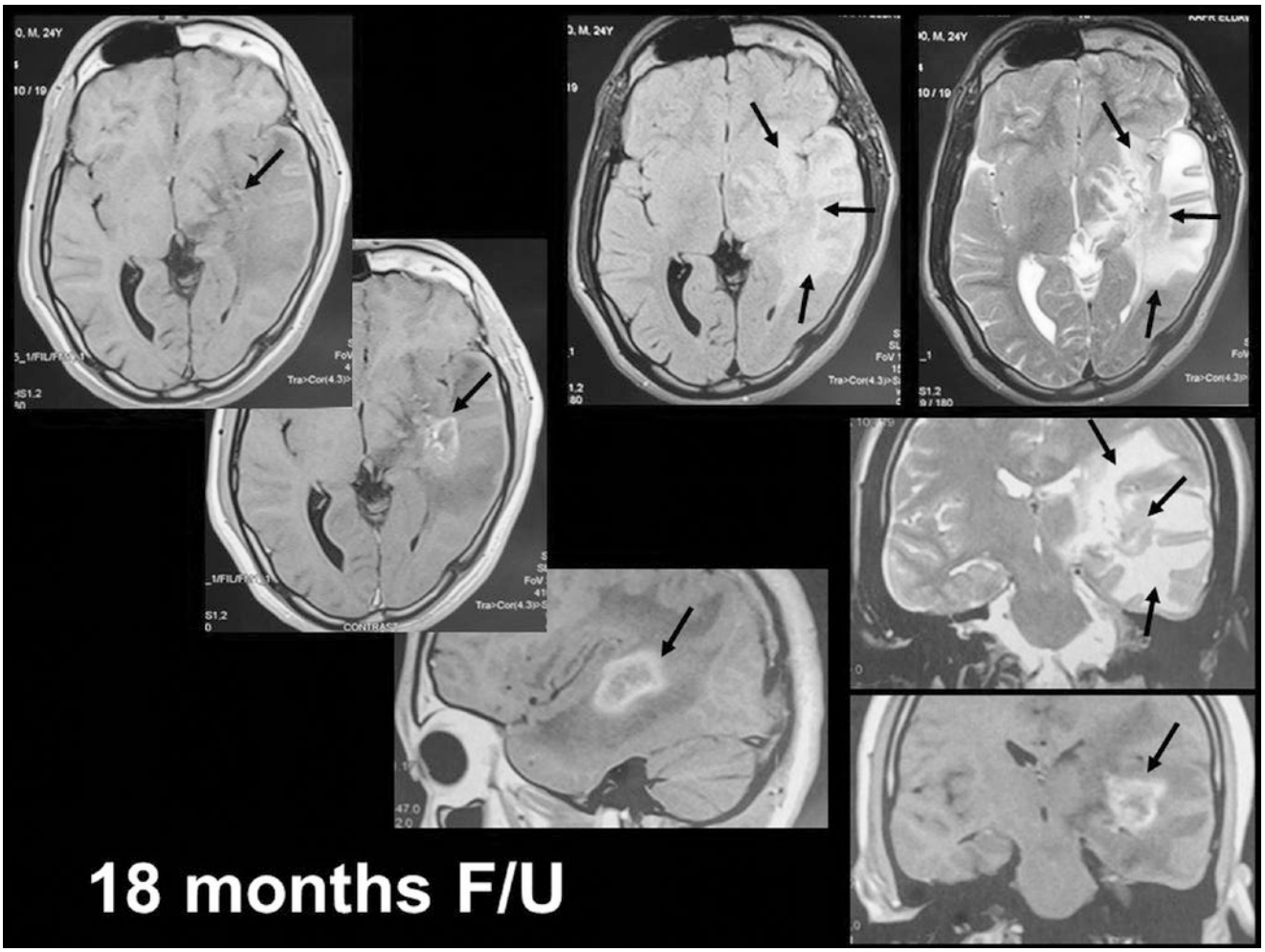
- **Complications:**
  - At 20 months post-SRS. the patient developed permanent right homonymous hemianopia, probably due to radiation-induced injury of left optic tract, which lies adjacent to AVM nidus.
  - Persistent infrequent generalized seizures, despite continued medical treatment
- **Radiological outcome:**
  - 6 months post-SRS (MRI):
    Mild decrease in size of AVM nidus
  - 12 months post-SRS (MRI):
    More decrease in size of AVM nidus
    Appearance of perinidal high signal in T2 and FLAIR studies, denoting vasogenic edema
    Appearance of nidal and perinidal, focal, heterogeneously enhancing lesion, in T1 Gadolinium-enhanced study, denoting radiation necrosis
  - 17 months post-SRS (MRI):
    More marked decrease in size of AVM nidus
    Marked increase of perinidal vasogenic edema, causing focal pressure effect and midline brain shift
    Marked increase of nidal and perinidal, focal, heterogeneously enhancing radiation necrosis, in T1 Gadolinium-enhanced study
  - 20 months post-SRS (MRI):
    Non-visualized AVM nidus
    More increase of perinidal vasogenic edema, causing more focal pressure effect and midline brain shift
    More increase of nidal and perinidal, focal, heterogeneously enhancing radiation necrosis, in T1 Gadolinium-enhanced study
  - 22 months post-SRS (MRS):
    Slightly increased Choline (Cho) and normal N-acetyl aspartate (NAA) and Creatine (Cr) signal intensities, indicative of radiation-induced injury
  - 24 months post-SRS (CTA): Non-visualized AVM nidus
  - 30 months post-SRS (MRI):
    Non-visualized AVM nidus
    Appearance of focal encephalomalacia at the site of prior AVM nidus
    Resolution of vasogenic edema-associated high signal in T2 and FLAIR studies at the site of prior AVM nidus
    Resolution of previously described nidal and perinidal radiation necrosis
    Associated negative mass effect as mild ex-vacuo dilatation of the left lateral ventricle
  - 36 months post-SRS (CTA):
    Complete obliteration of AVM nidus
    Small calcific foci are seen within the area of encephalomalacia at the site of prior AVM nidus
- **Post-radiosurgery Treatment:**
  - Continued clinical and radiological follow-up
  - Planning for conventional cerebral angiography study
  - Continued anticonvulsant medications

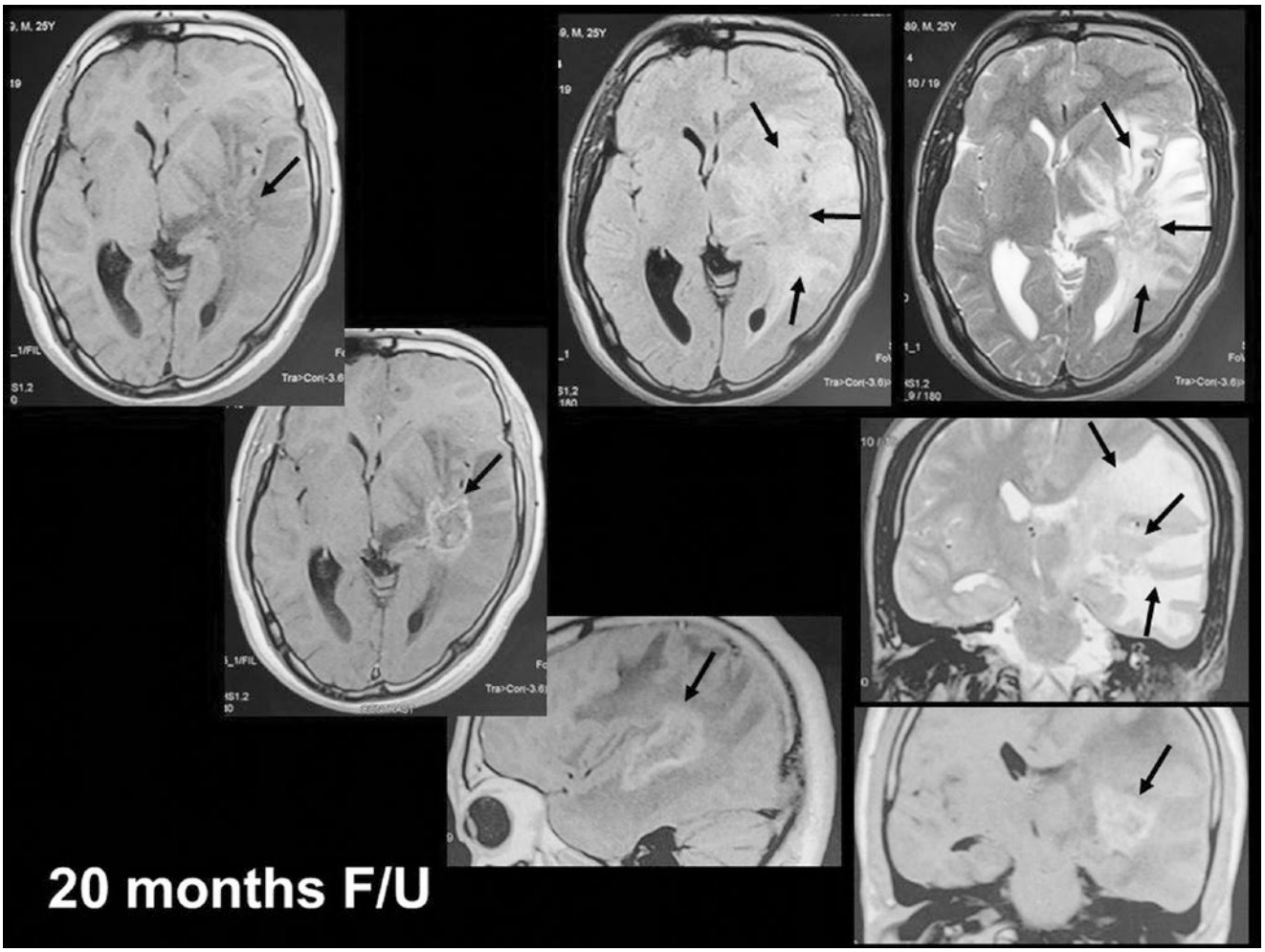

Before SRS

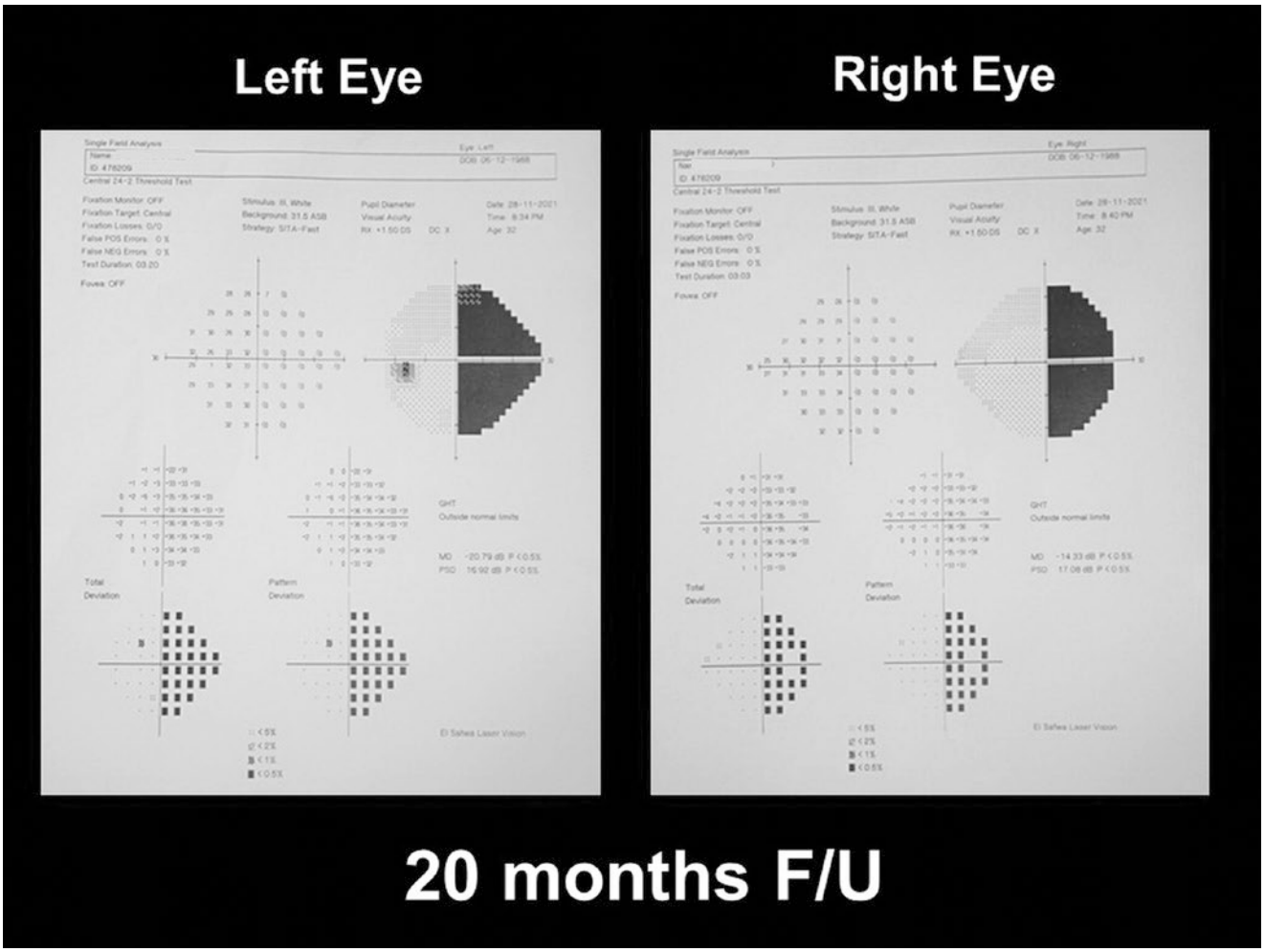

18 Gy at 80% Isodose Line
(2 Isocentric Plan)
-SRP in progress–Avm VOI 2
volume [%]
dose [%]
0 10 20 30 40 50 60 70 80 90 100
from slice 27 to 39
dose: 100% = 22.5 Gy, volume: 100% = 2.9 ccm
Treatment Plan

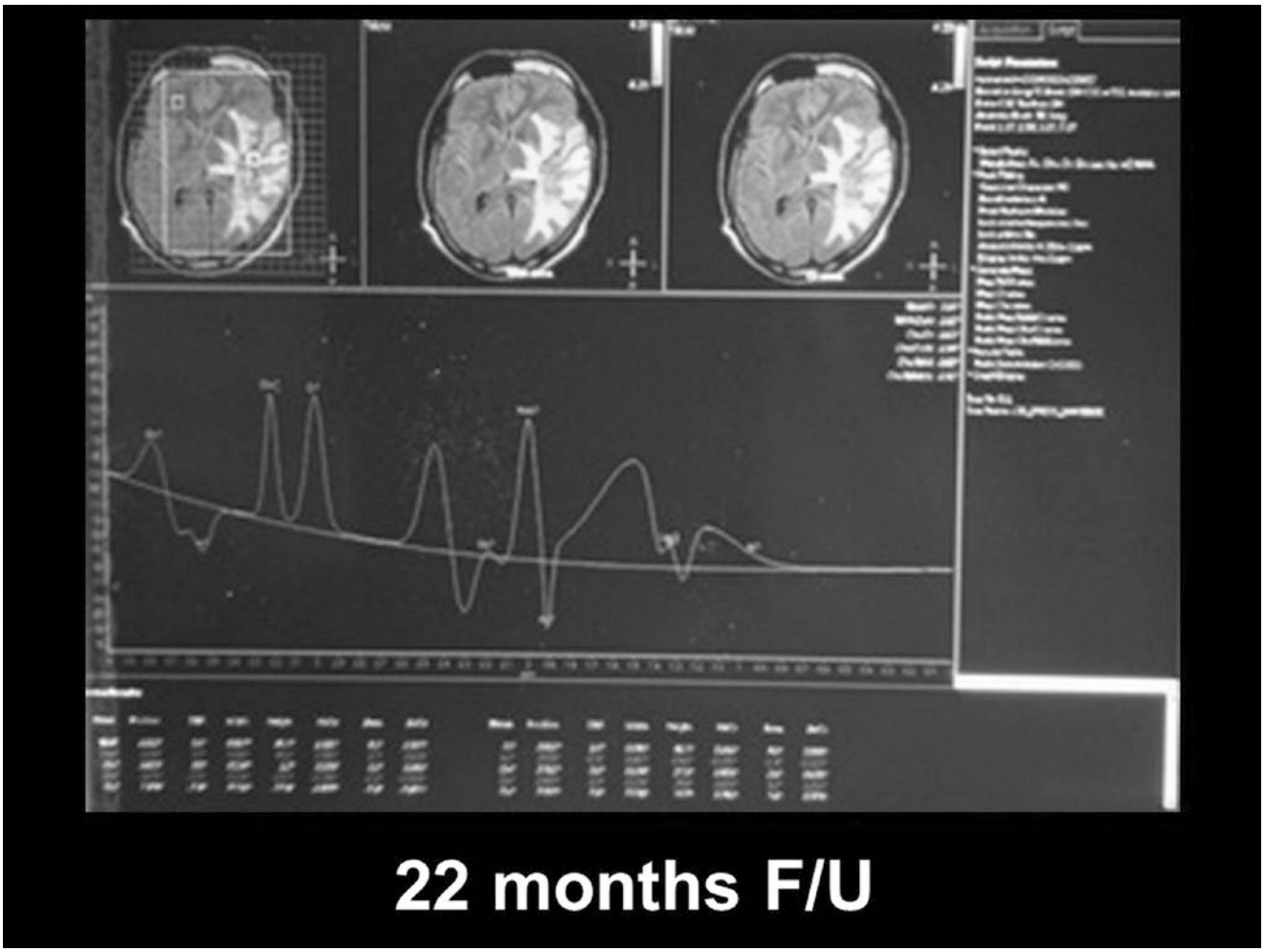

6 months F/U

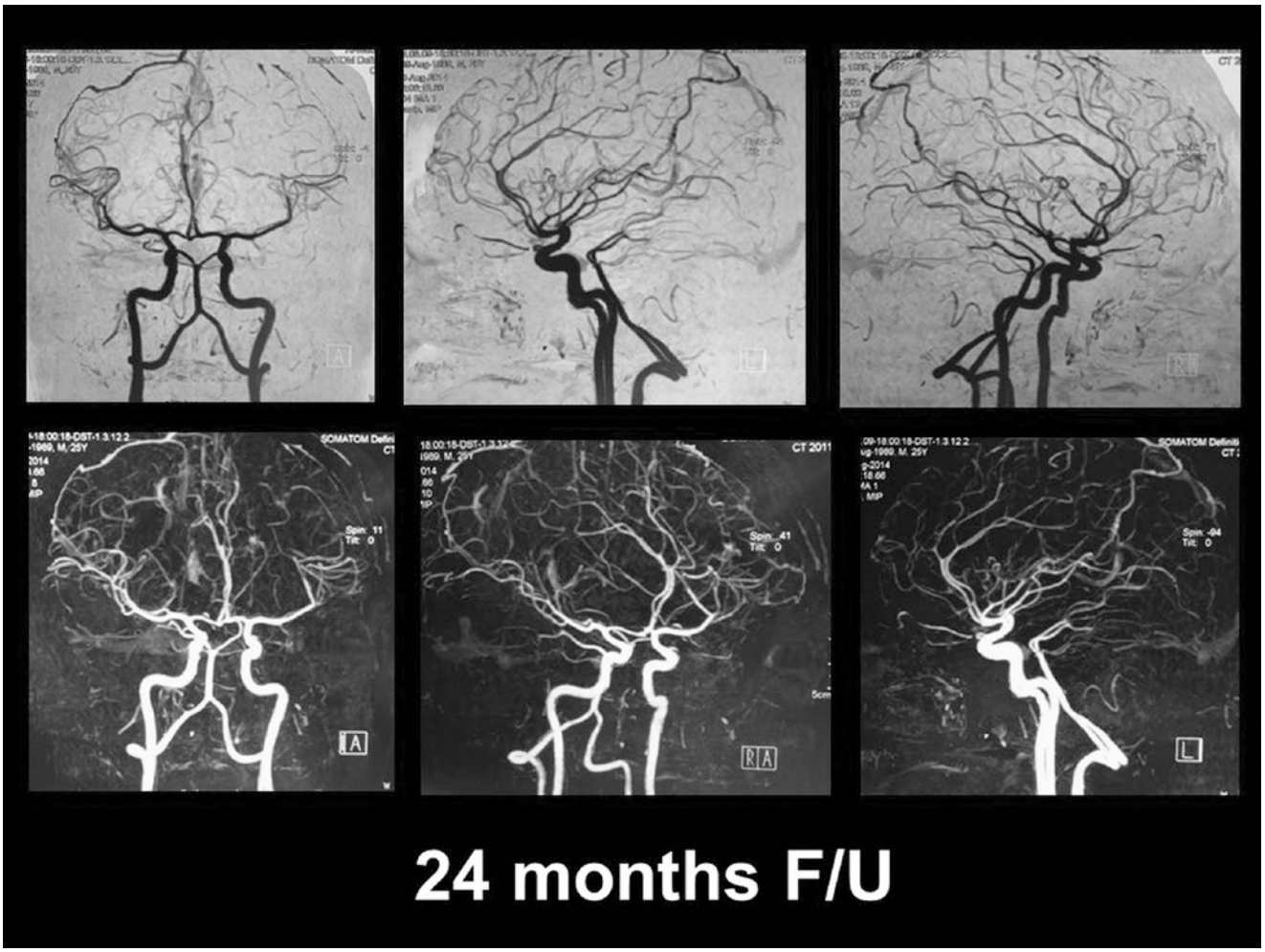

12 months F/U

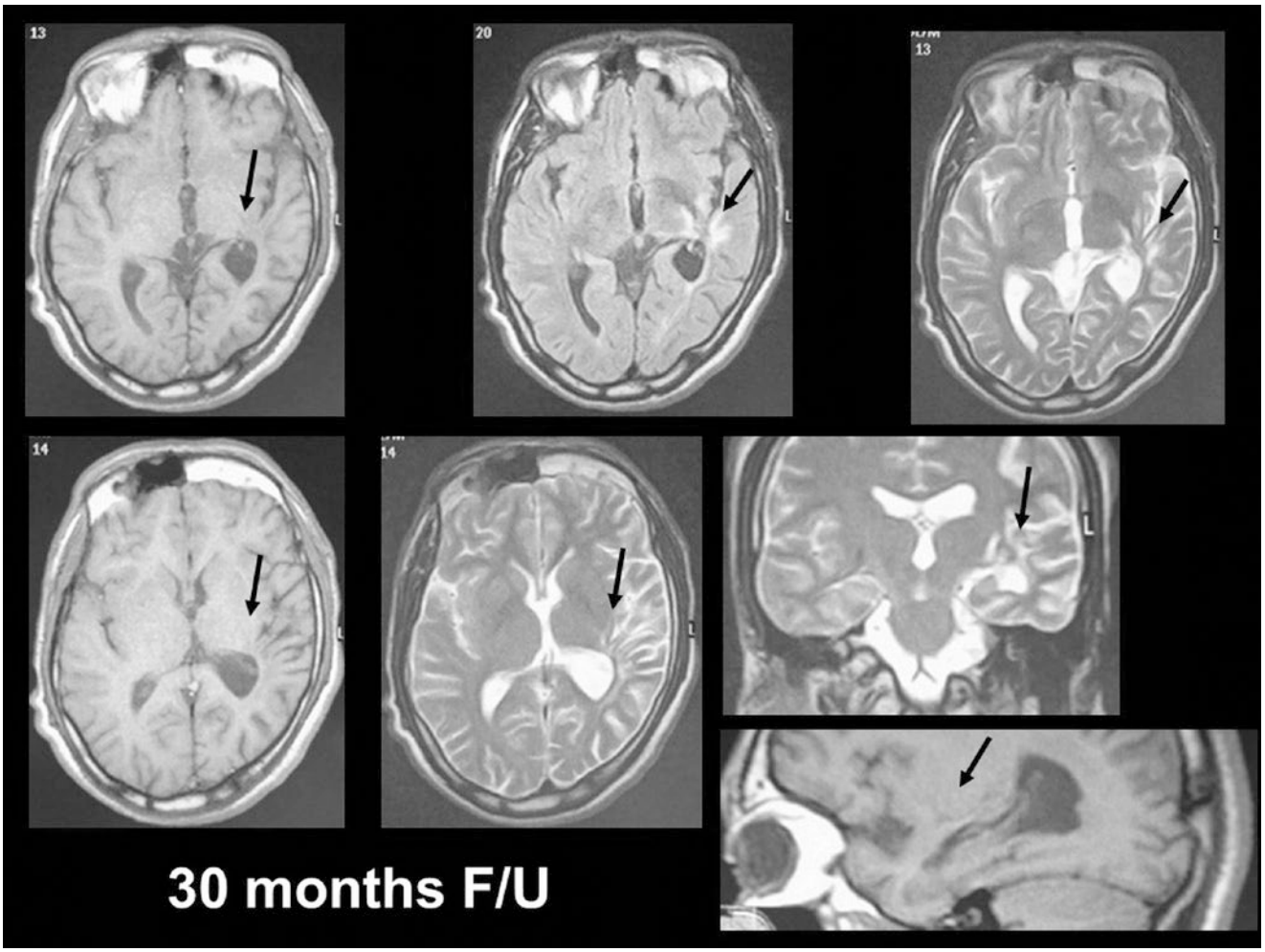

18 months F/U


20 months F/U


Left Eye
Right Eye
20 months F/U


22 months F/U


24 months F/U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20
13
14
14
30 months F/U

Further Reading

Daou BJ, Palmateer G, Wilkinson DA, et al. Radiation-induced imaging changes and cerebral edema following stereotactic radiosurgery for brain AVMs. Am J Neuroradiol. 2020;42(1):82–7. https://doi.org/10.3174/ajnr.A6880.

Ilyas A, Chen CJ, Ding D, et al. Radiation-induced changes after stereotactic radiosurgery for brain arteriovenous malformations: a systematic review and meta-analysis. Neurosurgery. 2018;83(3):365–76.

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Yen CP, Matsumoto JA, Wintermark M, et al. Radiation-induced imaging changes following Gamma Knife surgery for cerebral arteriovenous malformations. J Neurosurg. 2013;118(1):63–73.