HITBI plus
Heavy Ion Therapy Research Integration

Radiosurgery for **Skullbase Meningioma**

Dr **Christos BOSKOS**

Radiosurgeon / Radiation-Oncologist

St. LUKE'S HOSPITAL

IATROPOLIS
MEDICAL GROUP OF COMPANIES

StereotacticRadiosurgery.gr
"All about Radiosurgery in Greece"

I have no conflict of interest to disclose

My experience in Charged Particles: **Protontherapy**

Centre Protontherapie Orsay (Paris) 2003 (resident)

Centre Protontherapie Orsay (Paris) 2006-2008

My experience in **Stereotactic Radiosurgery**

Saint Savvas Hospital (Athens) **Elekta** 2001-2005 (resident)

Hopital Pitie-Salpetriere (Paris) **Varian BrainLab** 2006-2009

UCLA (Los Angeles) **Novalis BrainLab** 2007

Iatropolis Radiosurgery Center (Athens) **CyberKnife Accuray** 2019

Metropolitan Clinic (Athens) **EDGE Varian** 2021

Saint Lukas Clinic (Thessaloniki) **EDGE Varian** 2024

Diplome Universite in **Stereotactic Radiosurgery** and **Protontherapy**

Universite Pierre and Marie Curie (Paris VI)
2010

REPUBLIQUE FRANÇAISE
ACADEMIE DE PARIS

UNIVERSITE PARIS VI
Unité de Formation et de Recherche de Médecine
PIERRE ET MARIE CURIE

Site Pitié-Salpêtrière

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DIPLOME D'UNIVERSITE 'RADIOCHIRURGIE ET RADIOTHERAPIE EN CONDITIONS STEREOTAXIQUES INTRA ET EXTRACRANIENNES'

LE PRESIDENT DE L'UNIVERSITE PIERRE ET MARIE CURIE certifie que

M. Christos BOSKOS, né le 01 OCTOBRE 1969 à PELLA (GRECE),
a subi avec succès, lors de la session du 16 septembre 2009 , les épreuves prescrites pour l'obtention du DIPLOME D'UNIVERSITE 'RADIOCHIRURGIE ET RADIOTHERAPIE EN CONDITIONS STEREOTAXIQUES INTRA ET EXTRACRANIENNES'.
Vu l'arrêté du 12 juillet 2007, portant création à ladite UNIVERSITÉ du DIPLOME D'UNIVERSITE 'RADIOCHIRURGIE ET RADIOTHERAPIE EN CONDITIONS STEREOTAXIQUES INTRA ET EXTRACRANIENNES' ;

LE PRESIDENT DE L'UNIVERSITÉ PIERRE ET MARIE CURIE
délivre le présent certificat à **M. Christos BOSKOS.**

Pour le Président
Le Vice-président Médecine

Fait à Paris, le 21 septembre 2009

Signature du titulaire

Le Président

Bruno RIOU

Le Directeur de l'U.F.R. de Médecine
SERGE UZAN

JEAN-CHARLES POMEROL

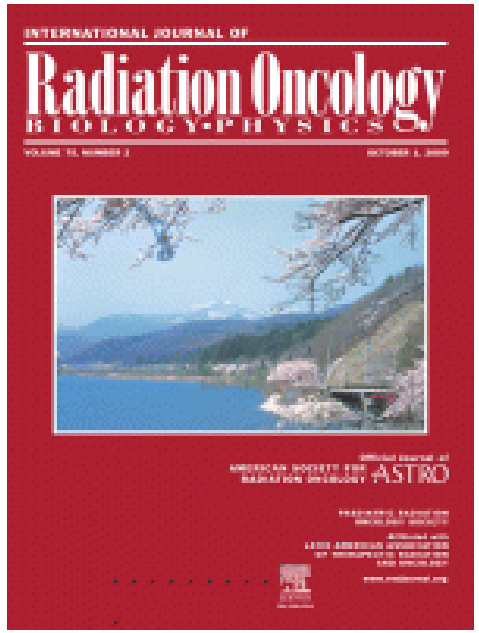
N° 75 VIK 1

StereotacticRadiosurgery.gr
"All about Radiosurgery in Greece"

Research in Protontherapy: **Skullbase Meningioma**

“Combined proton and photon conformal radiotherapy for intracranial atypical and malignant meningioma”,

Christos Boskos [1], **Loic Feuvret**, **Georges Noel**, Jean-Louis Habrand, Pascal Pommier, Claire Alapetite, Hamid Mammar, Regis Ferrand, Gilbert Boisserie, Jean-Jacques Mazeron



***Boskos** et al., Int J Radiat Oncol Biol Phys. 2009 Oct 1*

“Focal” is better…

- Radiosurgery
- Protontherapy

But **“Focal + radiobiology advantage”** is…

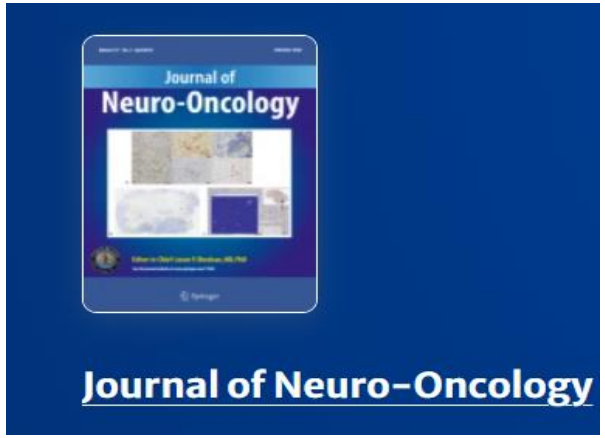
- Carbon ions

<u>far better</u>

Challenges for Skullbase Meningiomas

- Meningioma most **common** benign CNS tumor
- **Increasing incidence** as population grow older
- **Imaging quality progression** (easier define **residual** and **relapse**)
- **Factors** affecting management decision (age, volume, location, Simpson grade)
- Skullbase is a high risk area for **surgical complications**

Skull base meningiomas



- **Female** 74% and **white race** 79%
- **Benign**
- **Atypical** meningiomas are not considered either benign or malignant. They can become **malignant**
- **Grade II** and **III** almost **7%** National Database (SEER)

Alfredo Quinones Hinojosa J Neurooncology **2020**

skull base meningiomas had **<u>better LC</u>** when compared to those located at the **convexity** of the brain has been reported previously

Pou P., Biau J., Verrelle P., Lemaire J.J., El Ouadih Y., Chassin V., Magnier F., Dedieu V., Lapeyre M., Dupic G., et al. Long-Term Outcomes After Linac Radiosurgery for Benign Meningiomas. *Clin. Oncol.* **2020**

skull base meningiomas

Lower probability of high-grade histology when compared to those located at the rest of the brain

Maclean J., Fersht N., Short S. Controversies in Radiotherapy for Meningioma. *Clin. Oncol.* **2014**

Slower growth of skull base meningiomas

Hashimoto N., Rabo C.S., Okita Y., Kinoshita M., Kagawa N., Fujimoto Y., Morii E., Kishima H., Maruno M., Kato A., et al. Slower growth of skull base meningiomas compared with non–skull base meningiomas based on volumetric and biological studies: Clinical article. *J. Neurosurg.* **2012**

Lower MIB1 proliferation index in skull base meningiomas

McGovern S.L., Aldape K.D., Munsell M.F., Mahajan A., DeMonte F., Woo S.Y. A comparison of World Health Organization tumor grades at recurrence in patients with non–skull base and skull base meningiomas: Clinical article. *J. Neurosurg.* **2010**

skull base meningiomas **originate**

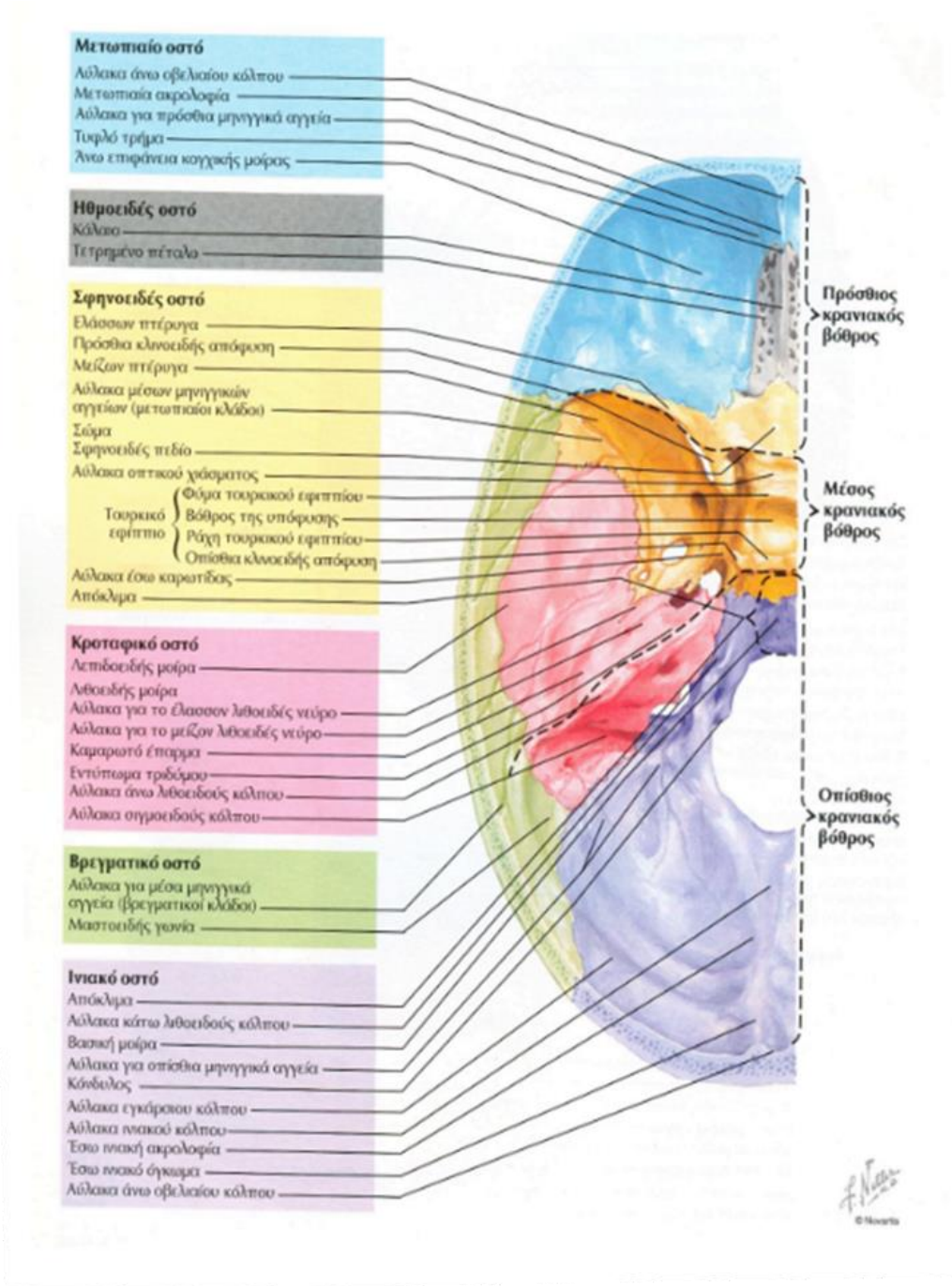
originate from a **variety of different structures** including, but are not limited to:

- clinoid processes,
- tuberculum sellae,
- dorsum sellae,
- sphenoid wing,
- petrous/petroclival area,
- falcotentorial region,
- cerebellopontine angle,
- foramen magnum.

Skull base locations

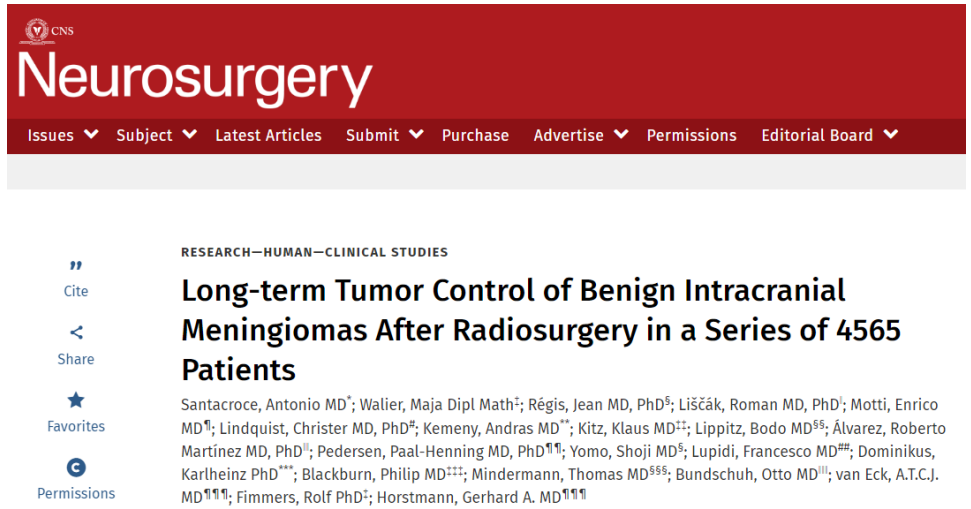
- Frontal fossa
- Median fossa
- Posterior fossa

- **Cavernous sinus** (CS)
- **CerebroPontal Angle** (CPA)
- **Petro Clival** (PC)



3754 skullbase meningiomas for SRS

- Cerebellum Pontine Angle 432
- Petro Clival 468
- Cavernous sinus 1272



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RESEARCH—HUMAN—CLINICAL STUDIES

Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients

Santacroce, Antonio MD; Walier, Maja Dipl Math; Régis, Jean MD, PhD; Liščák, Roman MD, PhD; Motti, Enrico MD; Lindquist, Christer MD, PhD; Kemeny, Andras MD; Kitz, Klaus MD; Lippitz, Bodo MD; Álvarez, Roberto Martínez MD, PhD; Pedersen, Paal-Henning MD, PhD; Yomo, Shoji MD; Lupidi, Francesco MD; Dominikus, Karlheinz PhD; Blackburn, Philip MD; Mindermann, Thomas MD; Bundschuh, Otto MD; van Eck, A.T.C.J. MD; Fimmers, Rolf PhD; Horstmann, Gerhard A. MD

Santacrose et al. Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients **2011**

Skullbase meningiomas **irradiation**

- Main therapy **(single treatment)**
- Post-operative **(residual)**
- Post-operative **(relapse)**

- **VMAT**
- **Radiosurgery**
- **Particles Radiotherapy**

ISRS guidelines for Cavernus Sinus meningioma SRS

ISRS
International Stereotactic Radiosurgery Society

TABLE 4. Recommendations for Management of CS Meningioma	
Evidence level	
Level III	SRS/SRT is recommended as a primary/upfront treatment option for an asymptomatic, or mildly symptomatic CS meningioma. The recurrence rate is not appreciably different between primary or adjuvant therapy for a CS meningioma
Level III	Resection should be considered for the treatment of larger and symptomatic CS meningioma in patients both receptive to, and medically eligible, for open surgery
Level III	SRS/SRT delivered to a CS meningioma has a low risk of complications; most cranial nerve functions are preserved or improved due to tumor shrinkage. Carotid artery stenosis after SRS is rare.
Level III	When no residual tumor is observed, or only a small tumor lining on the dura of the CS exists postoperatively, serial neuroimaging studies is not unreasonable. At the time of recurrence or progression of residual tumor, SRS/SRT should be considered
Level III	In patients with a CS meningioma that has rapidly and substantially recurred after prior treatment, a subtotal surgical resection or biopsy may be considered. More aggressive features of the tumor (transformation of the tumor from WHO grade I to a higher grade) should be ruled out. These tumors have a predilection for progression and postoperative SRS/SRT with a higher dose should be strongly considered.
Level III	The technique for SRS or SRT delivery will depend upon the tumor histology, tumor volume and proximity of the tumor to adjacent critical structures (eg, the optic chiasm). SRS using single session marginal doses of 11 to 16 Gy offers a local tumor control rate of 90% or higher at 5 yr post-SRS.

ISRS guidelines

Management of **cavernous sinus** meningiomas: Consensus statement on behalf of the **EANS** skull base section (2022)

Stereotactic RadiosurgerySRS (single-dose or fractionated) should be considered in the following cases, insofar as the distance to the **ON is superior to 3 mm** (Level C):
- **Asymptomatic, > 40 years** old patients with a **purely intracavernous** CSMs <2.5 cm showing growth on serial imaging after initial conservative treatment;
- **Asymptomatic** patients with **partly extracavernous** CSMs showing growth on serial imaging after initial conservative treatment;
- **Symptomatic** patients with CSMs <2.5 cm, provided that the symptoms are **not related to ON compression**
- **Symptomatic patients** with partly extracavernous CSMs in whom **surgery is contraindicated**.

fractionated SRS or RT should be considered in cases that warrant treatment (see above) if the distance to the **ON is less than 3 mm** and the ipsilateral visual function is good (Level C).

Brain and Spine 2 (2022) 100864

Contents lists available at ScienceDirect

Brain and Spine

journal homepage: www.journals.elsevier.com/brain-and-spine

Management of cavernous sinus meningiomas: Consensus statement on behalf of the EANS skull base section

Marco V. Corniola [a,b,c,d], Pierre-Hugues Roche [e], Michaël Bruneau [f], Luigi M. Cavallo [g], Roy T. Daniel [h], Mahmoud Messerer [h], Sebastien Froelich [i], Paul A. Gardner [j], Fred Gentili [k,†], Takeshi Kawase [l], Dimitrios Paraskevopoulos [m], Jean Régis [n], Henry W.S. Schroeder [o], Theodore H. Schwartz [p], Marc Sindou [q,r,s], Jan F. Cornelius [t], Marcos Tatagiba [u], Torstein R. Meling [d,v,*]

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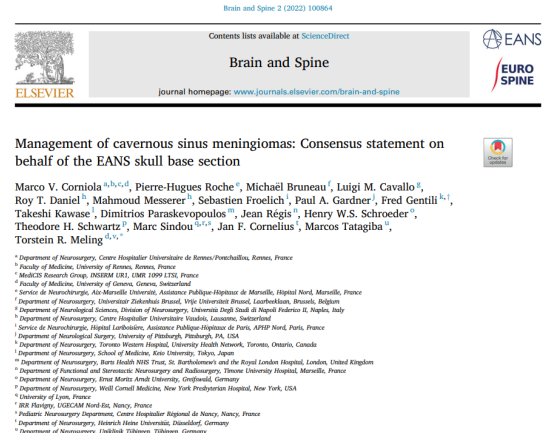
https://www.ncbi.nlm.nih.gov/pmc/articles/

EANS guidelines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Conclusions

- **SRS** should be advocated as <u>first line</u> treatment in **small/asymptomatic** lesions/in **elderly** patients.

- Offer **excellent tumour control** with **low rates of oculomotor/visual complications**.

- **Endoscopic Endonasal Approach (EEA)**, a safe strategy of **bony <u>skull base decompression</u>** and **<u>limited tumour removal</u>** in the **exophytic component** of the tumour, outside the cavernous sinus. **Combined with SRS** can be for **symptoms relief** and **tumour control**

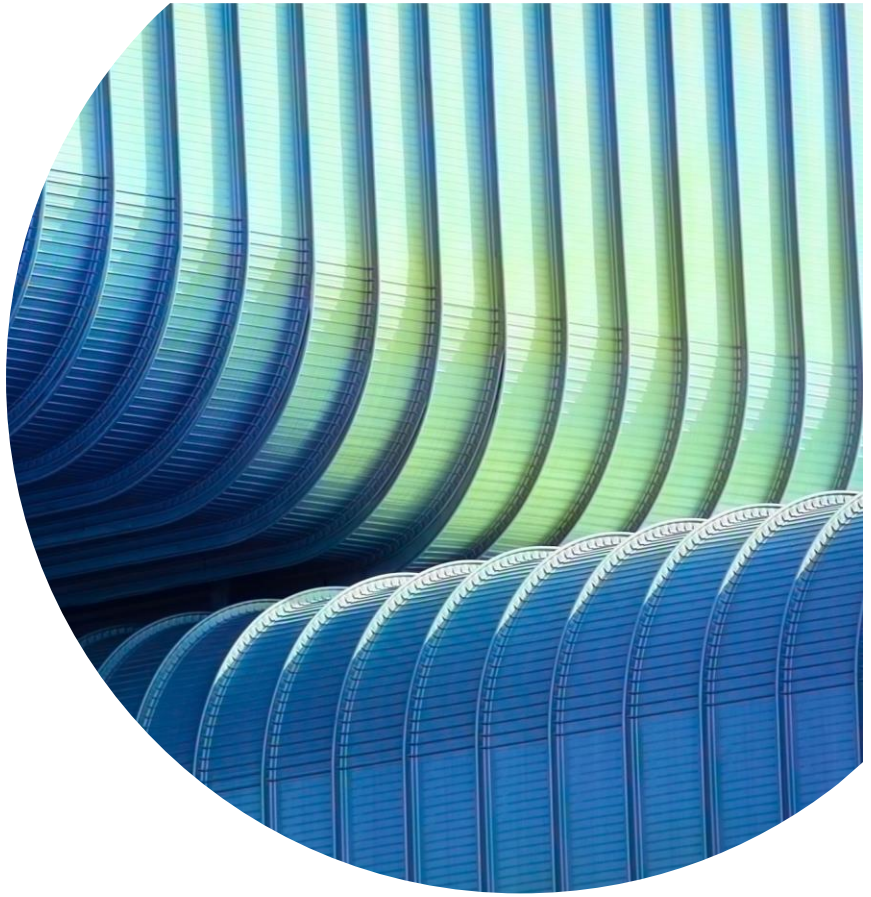
Radiosurgery for Skullbase meningioma

Radiosurgery - Definition

High dose in 1 fraction

High accuracy <1mm

High gradient of dose (rapid fall off dose) → normal tissue preservation



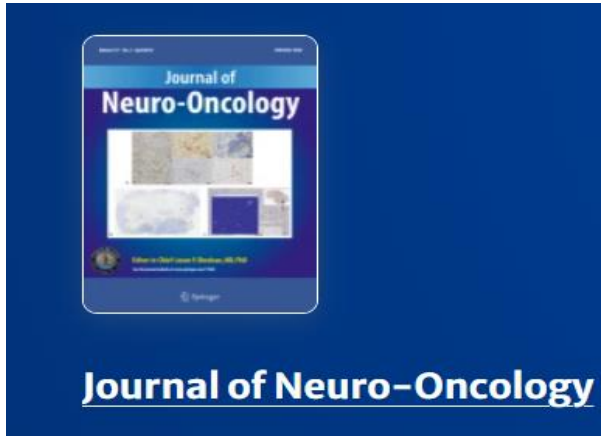
SRS Radiobiology

RADIOSURGERY:

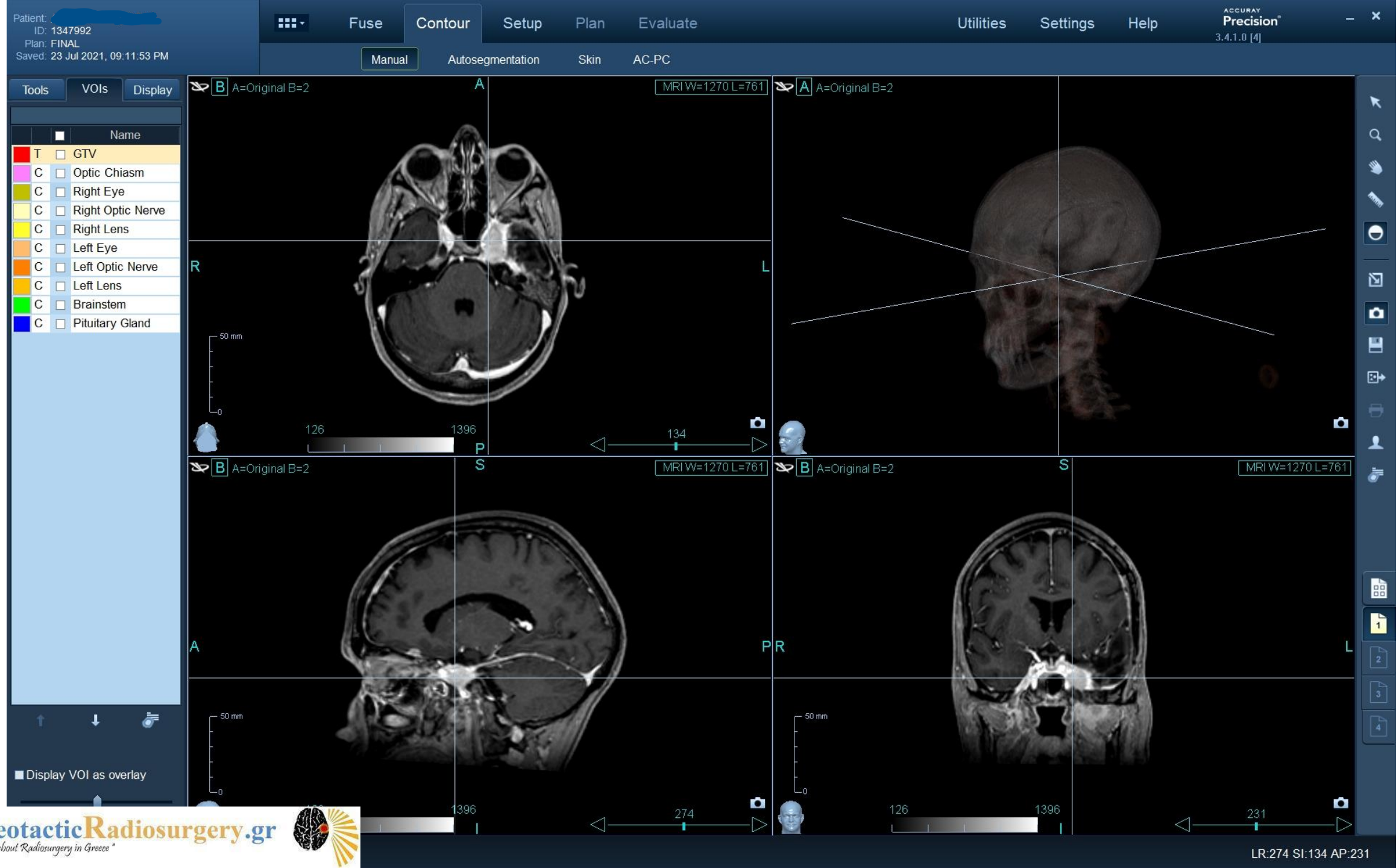
- creates **more double-strand breaks** in **DNA**,
- results in **less DNA damage repair**,
- has **anti-vascular effects**,
- Has ***in situ*** **vaccine effects** and **abscopal effect** (**immuno-stimulation** and **immuno-upregulation**)

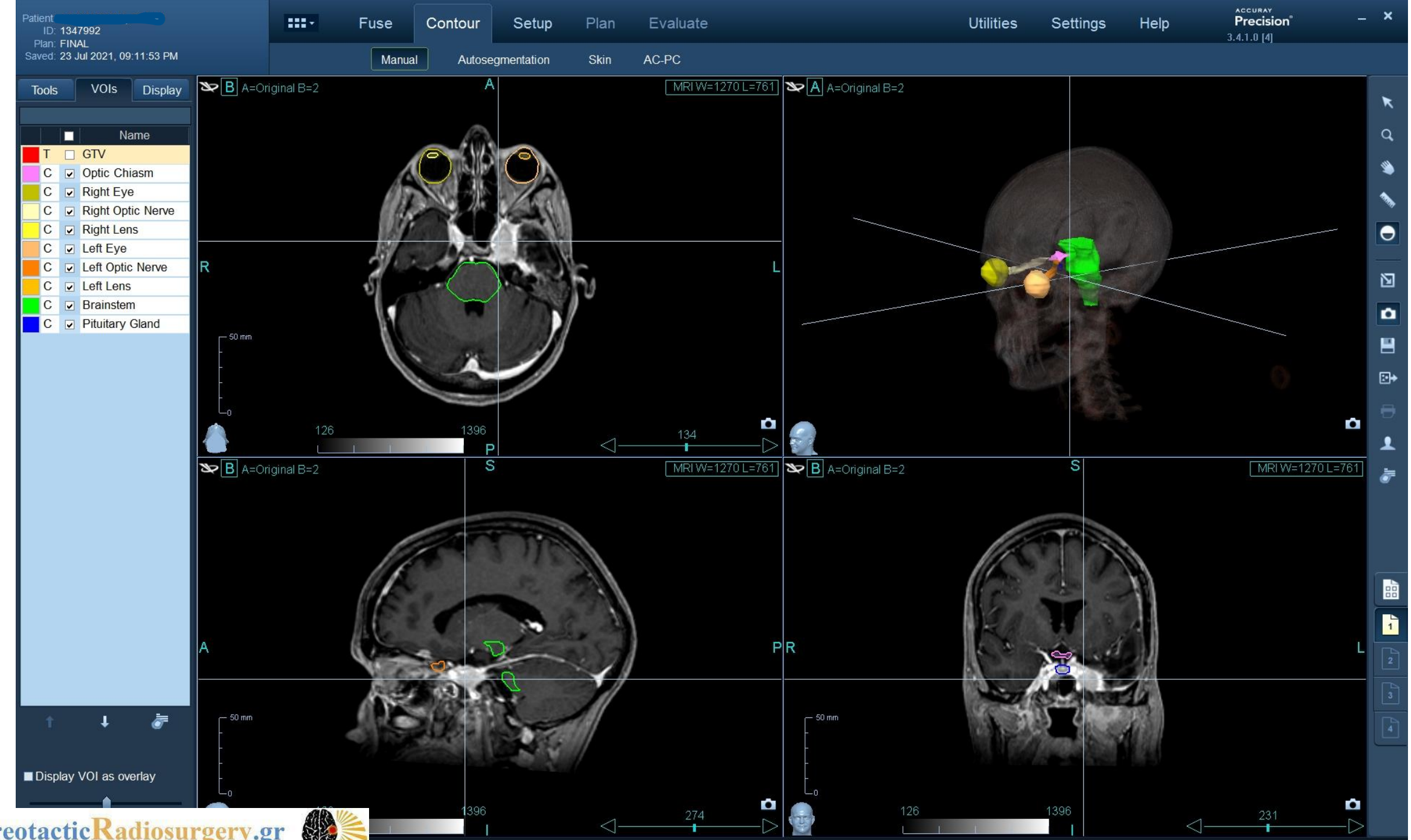
Factors for **SRS treatment desicion**

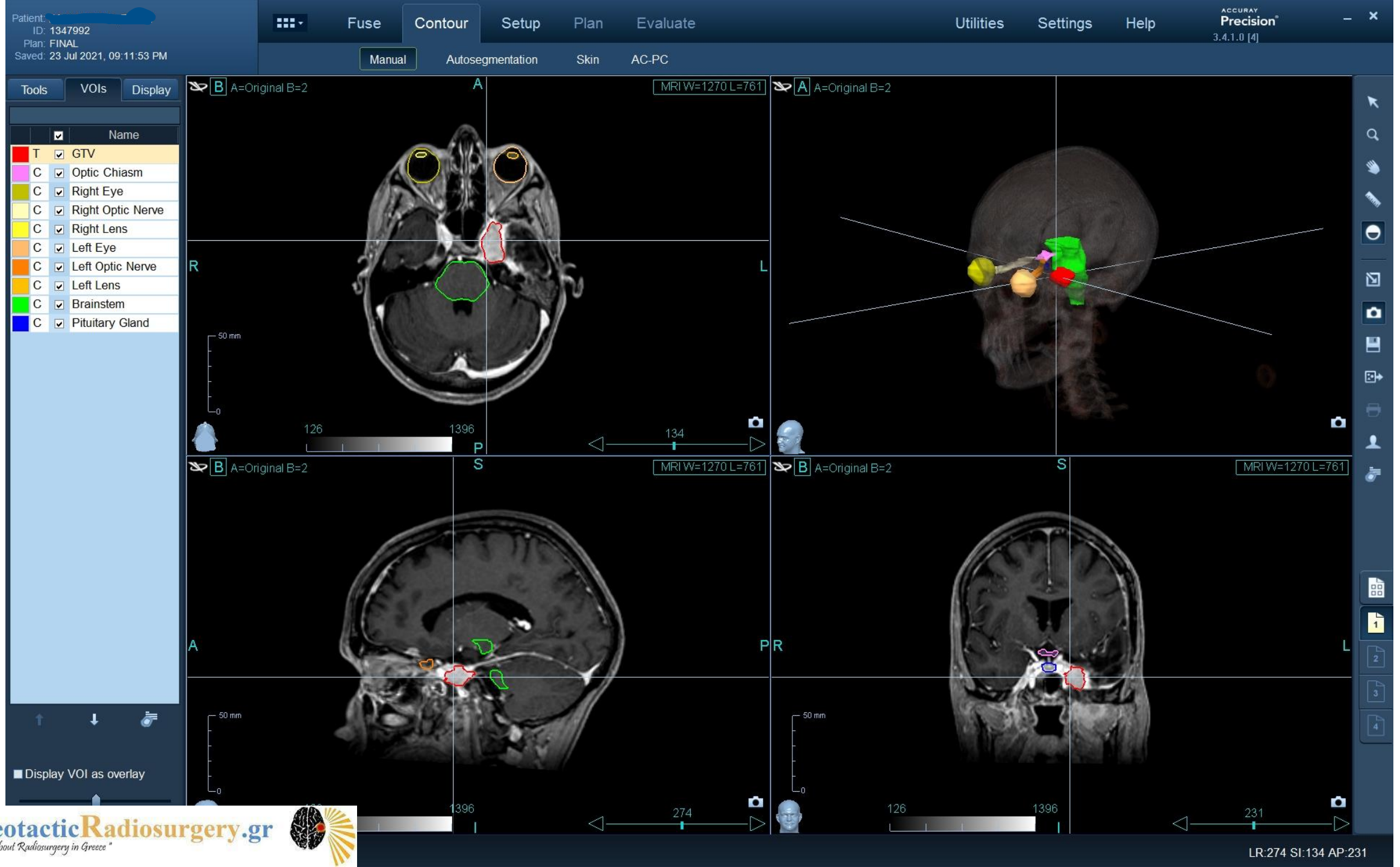
- Size
- Location
- Rate of growth (aggressiveness)
- Age
- Performance Status
- Patients goals for treatment (choice)



Alfredo Quinones Hinojosa
J Neurooncology 2020







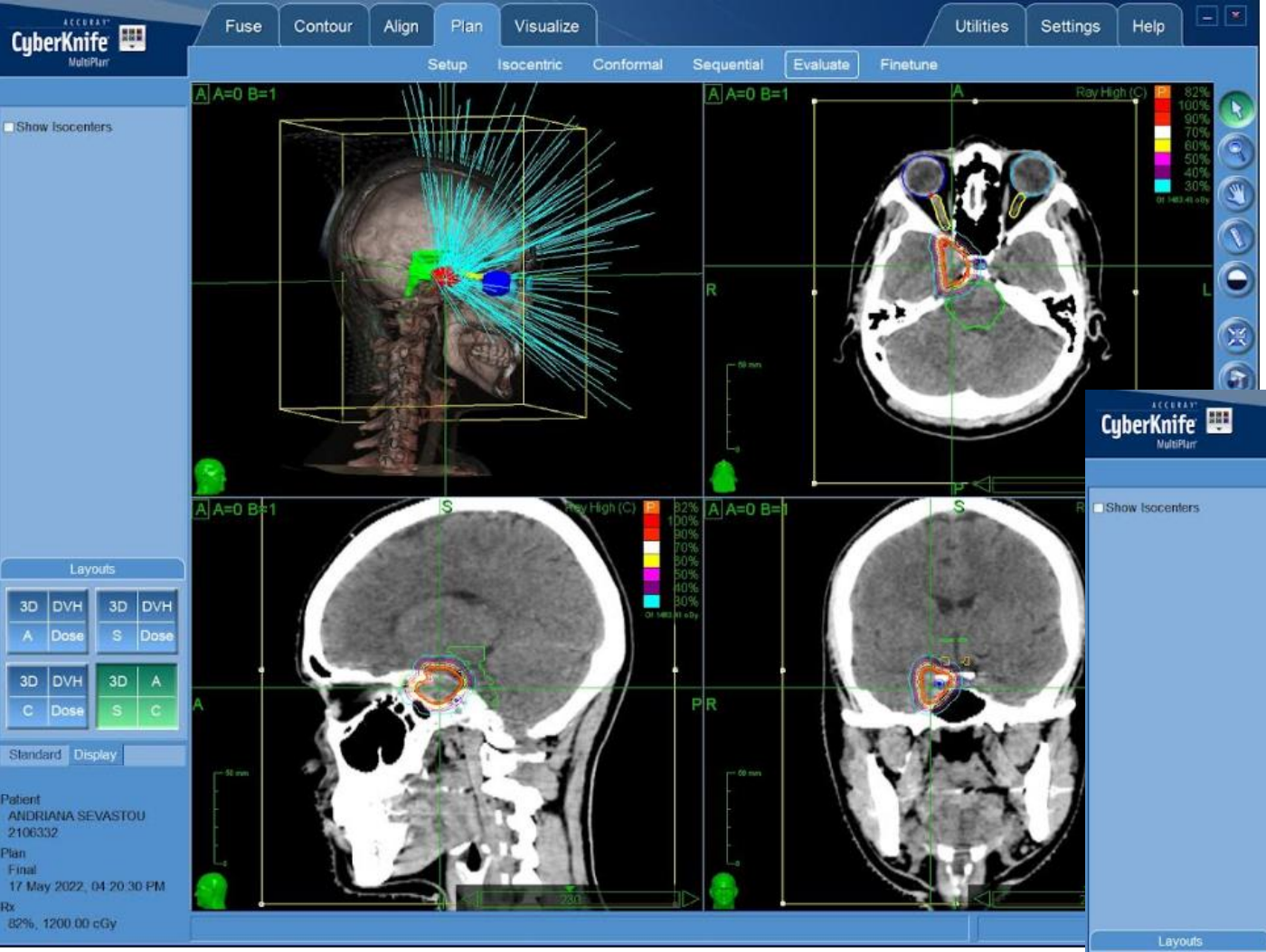
Prescription Dose

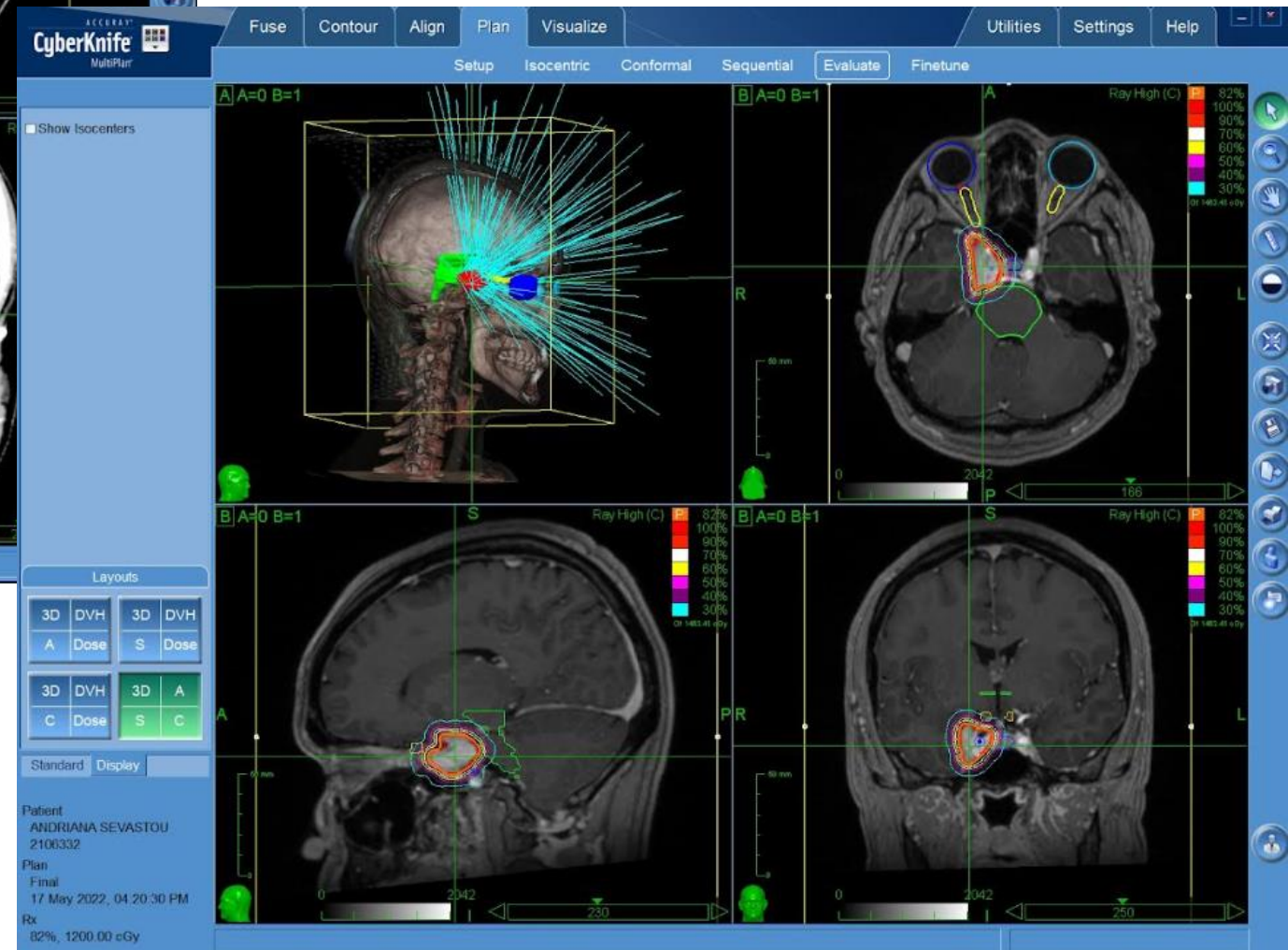
Single fraction: 12-13Gy

Dose (crute) (Local Control)
Dose conformality (Toxicity)
Dose fall off (Toxicity)

Dose and **Local Control**

11Gy possible working
12Gy – 13Gy standard working
14Gy+ working but…



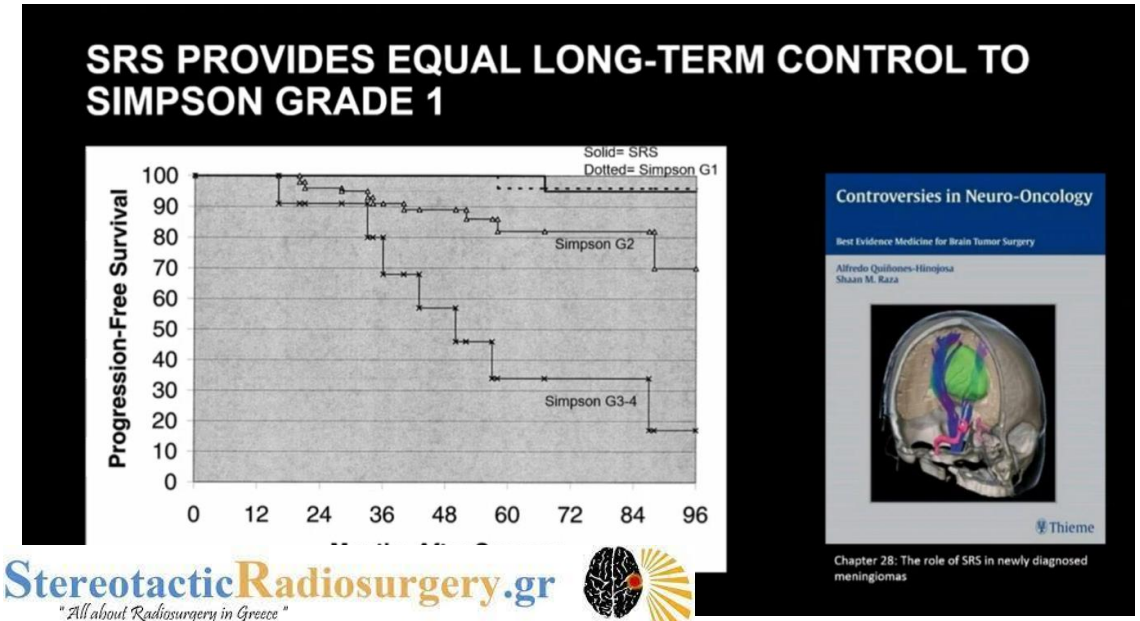


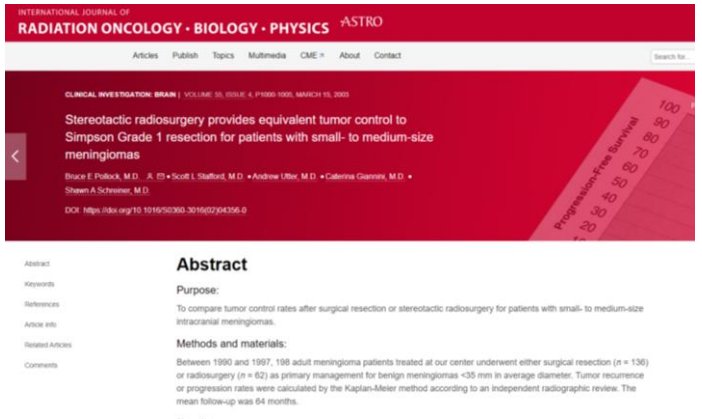
Radiosurgery outcomes

SRS equal long-term control to **Simpsons Grade 1**

No statistically significant difference was detected in the **3- and 7-year actuarial progression-free survival (PFS) rate** between patients with Simpson Grade 1 resections (100% and 96%) and patients who underwent radiosurgery (100% and 95%, p = 0.94).

198 patients , surgical resection (n = 136) or radiosurgery (n = 62) as primary management for benign meningioma

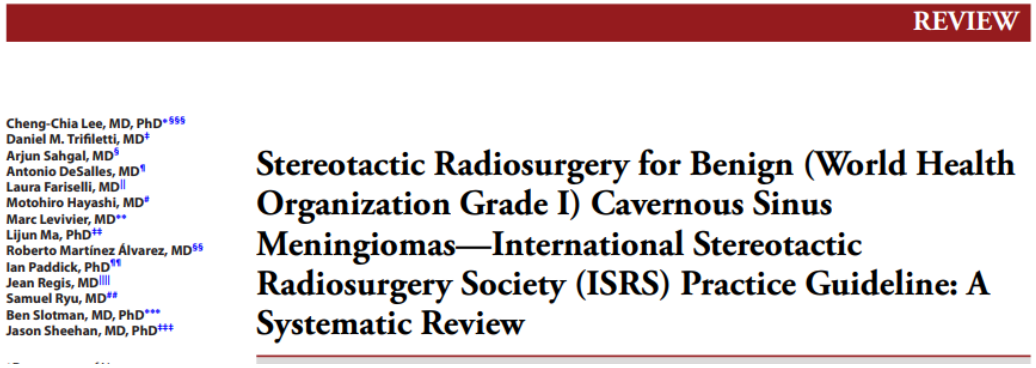




https://pubmed.ncbi.nlm

Pollock IJROBP **2003**

ISRS Guidelines for **Cavernous Sinus** Meningiomas


REVIEW

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Stereotactic Radiosurgery for Benign (World Health Organization Grade I) Cavernous Sinus Meningiomas—International Stereotactic Radiosurgery Society (ISRS) Practice Guideline: A Systematic Review

- 5-yr **PFS** 86% to 99%
- 10-yr **PFS** 69% to 97%
- 15-yr **PFS** rates 92%
- 20-yr **PFS** rates ranging from 87%

5- yr **Local Control** rate of 99%
10-yr **Local Control** rate of 93%

ISRS
International Stereotactic Radiosurgery Society

Skull base meningioma Local Control

Home › Journal of Neuro-Oncology › Article

Single session versus multisession stereotactic radiosurgery for the management of intracranial meningiomas: a systematic review and meta-analysis

Review | Published: 17 August 2022

Volume 161, pages 215–224, (2023) Cite this article

Othman Bin-Alamer, Nada Alnefaie, Jumanah Qedair, Adhiraj Chaudhary, Hana Hallak, Arif Abdulbaki, Arka N. Mallela, Paolo Palmisciano, Zachary C. Gersey, Andrew D. Legarreta, Mohamed A. Labib, Gabriel Zada, Jason P. Sheehan, William T. Couldwell, L. Dade Lunsford & Hussam Abou-Al-Shaar

	3years	5years	10 years	20years
Cavernus Sinus	94	91	85	72
Petroclival	97	95	94	86
C P Angle	95	90	86	81
Clinoid	95	93	88	82
Sphenoid Wing	96	96	90	90
Olfactory Groove	93	88	83	78
Tentorial	96	94	87	84

Othman Bin-Alamer et al, Neuro-Oncology, 2023

Clinical follow up SRS treated Skullbase Meningioma

Neurological improvement

- **CS 44.2%**
- PC 34%
- CPA 38.5%

Complete symptoms response

CS 23.2%

PC 15%

CPA11.5%

CS:Cavernous sinus

CPA:CerebroPontal Angle

PC:Petro Clival

Santacrose et al. Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients **2011**

Cranial nerve outcomes in patients who underwent **SRS** for **CS meningiomas**

with or without prior **microsurgery**

Improvement rates specific to **Cranial Nerve Deficits** after **SRS** :

- **20% at 1 yr,**
- **34% at 2 yr,**
- **36% at 3 yr, and**
- **39% at 5 yr.**

Kano H, Park KJ, Kondziolka D, et al. Neurosurgery. **2013**

Fractionated SRS

Fractionated SRS for Skullbase Meningioma

- Large Tumor **Volume**
- Proximity to **Optic Pathway**

- Lesion>30mm
- Lesion >15cc
- Lesion<2-3mm optic nerve distance

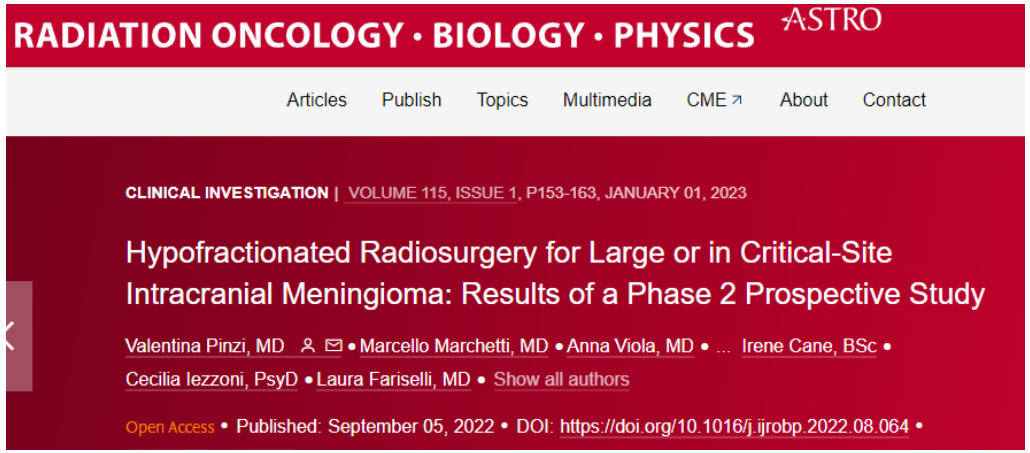
- Local Control ?
- Toxicity ?

https://www.redjournal.org/article/S0360-3016(22)03236-9/fulltext

Multi session SRS for meningiomas

Phase II Prospective study
Dose: **25Gy** in 5 fractions
N=178

5-year tumor control: 97%
Overal Toxicity:12,7%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CLINICAL INVESTIGATION | VOLUME 115, ISSUE 1, P153-163, JANUARY 01, 2023

Hypofractionated Radiosurgery for Large or in Critical-Site Intracranial Meningioma: Results of a Phase 2 Prospective Study

Valentina Pinzi, MD • Marcello Marchetti, MD • Anna Viola, MD • ... Irene Cane, BSc • Cecilia Iezzoni, PsyD • Laura Fariselli, MD • Show all authors

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https://www.redjournal.org/article/S0360-3016(2 Fariseli et al, **2023**

Image Guided Multisession Radiosurgery of Skullbase meningiomas

Retrospective Analysis
Dose: **25Gy** in 5 fractions
N=156

5-year tumor control: 90%

- **Progression-free survival** at **2-, 5-, and 10- years was 95%, 90%, and 80.8%,** respectively.
- There were **no new visual** or **motor deficits,** nor **cranial nerves impairments**, excluding trigeminal neuralgia, which was reported by 5.7% of patients.

cancers

MDPI

Article

Image-Guided Multisession Radiosurgery of Skull Base Meningiomas

Alfredo Conti [1,2,*], Antonio Pontoriero [3], Giuseppe Iatì [3], Salvatore M. Cardali [4], Anna Brogna [3], Filippo Friso [2], Vittoria Rosetti [2], Matteo Zoli [1,2], Silvana Parisi [3], Alberto Cacciola [3], Sara Lillo [3], Stefano Pergolizzi [3] and Diego Mazzatenta [1,2]

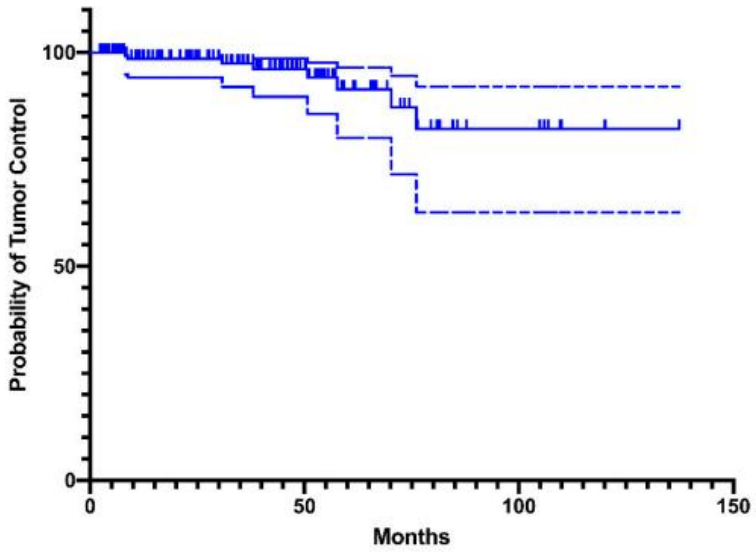


Figure 4. Progression-free survival (PFS) ± 95% confidence interval.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7761100/pdf/

Conti et al,Cancers **2022**

Radiobiological advantage in fractionation?

Assessment of the **α/ß ratios** for meningiomas

Assessment of the α/ß ratios for arteriovenous malformations, meningiomas, acoustic neuromas, and the optic chiasma

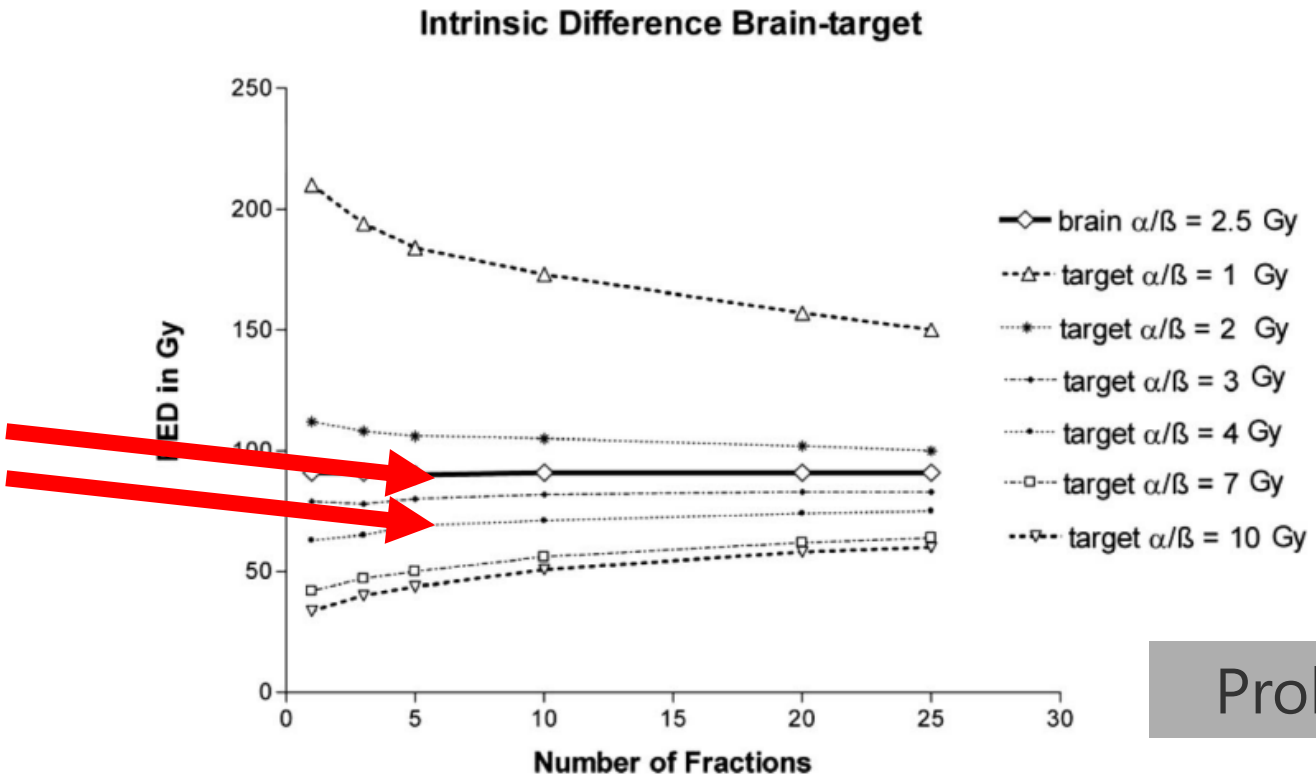
https://www.tandfonline.com/doi/full/10.3109/09553001003667982

Assessment of the α/ß ratios for arteriovenous malformations, meningiomas, acoustic neuromas, and the optic chiasma

Frederik J. A. I. Vernimmen & Jacobus P. Slabbert

Pages 486-498 | Received 23 Jan 2009, Accepted 29 Jan 2010, Published online: 15 May 2010

Cite this article https://doi.org/10.3109/09553001003667982



Brain normal tissue alpha/beta 2.5

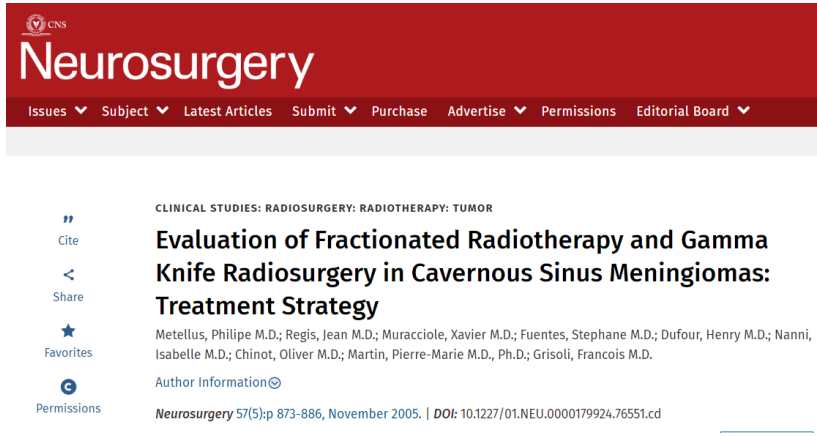
meningiomas alpha/beta 3.3 – 3.7

Probably **not so much** as we think

Figure 6. BED variations for a number of target α/ß values in relation to the brain. The brain maintains a constant effect (constant BED value) across a number of isoeffective schedules of increasing number of fractions. Whit the physical dose to the target and the brain being the same for each fractionation schedule, a changing BED for the target can be seen across the spectrum of fractionations.

https://www.tandfonline.c Frederik J. A , South Africa, May **2010**

SRS vs. **SRT** CS Meningioma: **tumor shrinkage ???**



However, radiologically 29% of patients who underwent SRT, and 53% of patients who underwent **SRS**, showed **tumor shrinkage (P < .04)**

The result implied that **SRS** offered a **higher rate of tumor shrinkage**, but no significance in clinical improvement.

Metellus P, **Regis J**, Muracciole X, et al. Evaluation of fractionated radiotherapy and gamma knife radiosurgery in cavernous sinus meningiomas: treatment strategy. Neurosurgery. **2005**

High Grade skullbase meningiomas

Grade II and **Grade III meningioma** criteria

Pathology grading

Grade II

- Brain invasion
- Few or more mitoses (<20 mitoses)
- Three of the following:
  - Increased cellularity
  - Prominent nucleoli
  - Loss of architecture
  - Necrosis
  - Small cell change

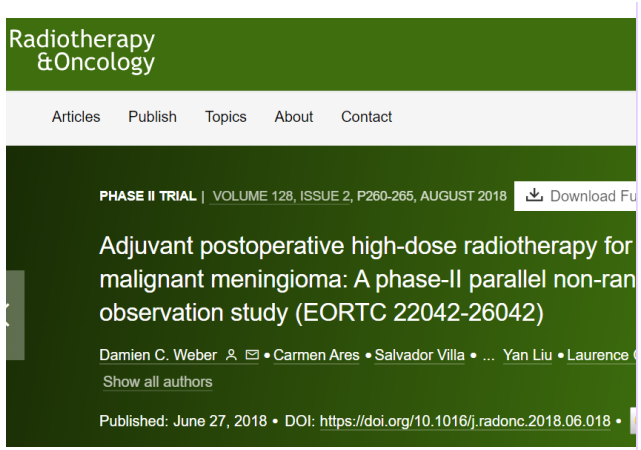
Grade III

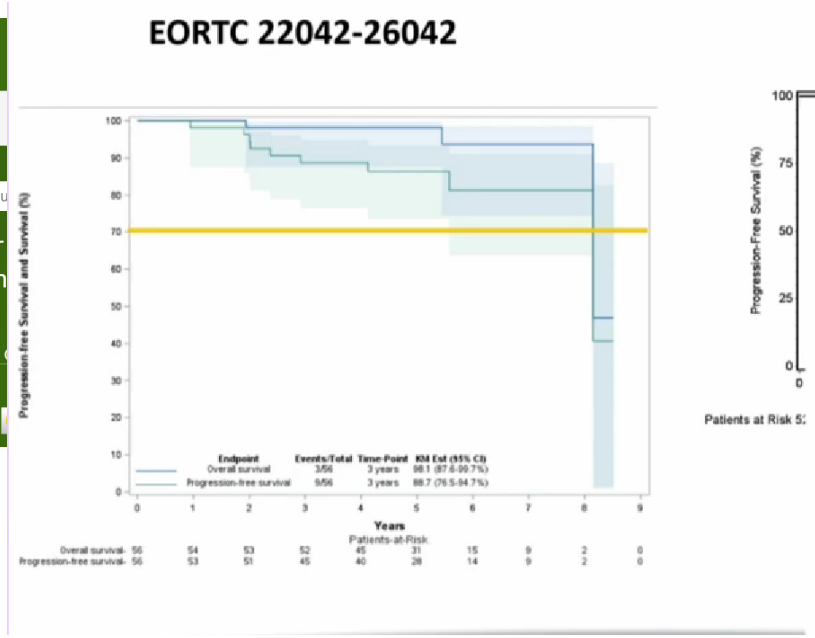
- Overt anaplasia
- >20 mitoses

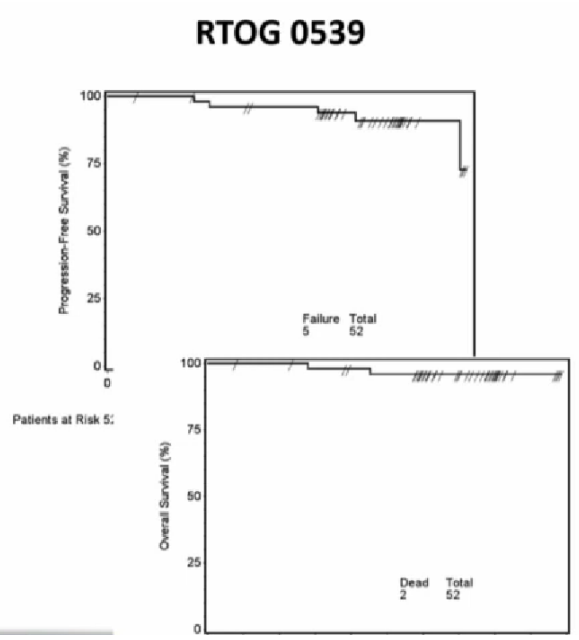
Grade II: **immediate** or **waiting** RT after GTR ?

- EORTC 22042-26042

RTOG 0539







Excellent results in Favor of **post-operative RT**

EORTC 22042-26042 and **RTOG 0539**

Using **modern RT technics** (like IMRT)

- we can deliver **higher dose** in the target, protecting the normal brain
- very low rate of **high grade late toxicity**

paradox

SRS :

- **higher conformity** in the target
- **increased dose gradient** outside the target (rapid fall off the dose)

Adjuvant SRS improves Post-surgical **long term outcomes** (regardless of the extent of resection)

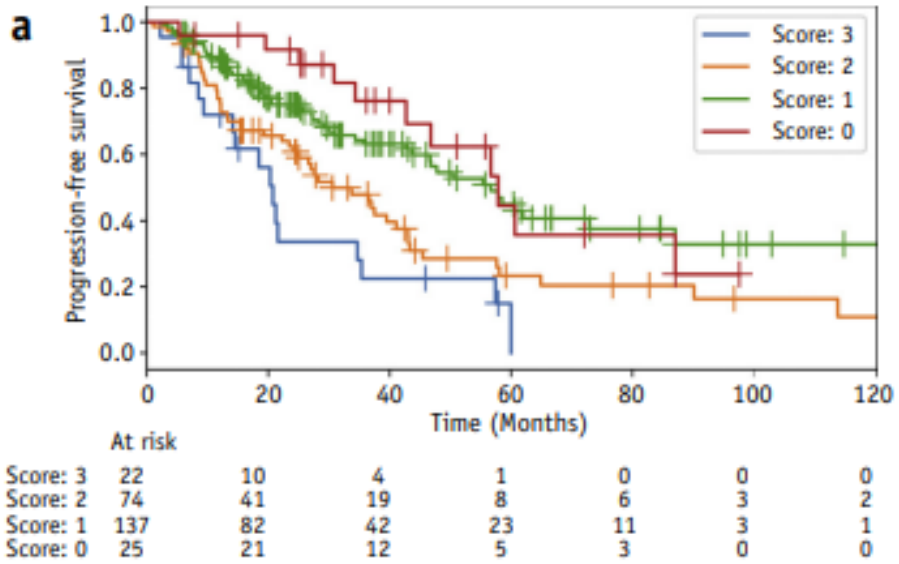
7486 patients,
6788 with **atypical meningiomas**
698 with **malignant meningiomas**

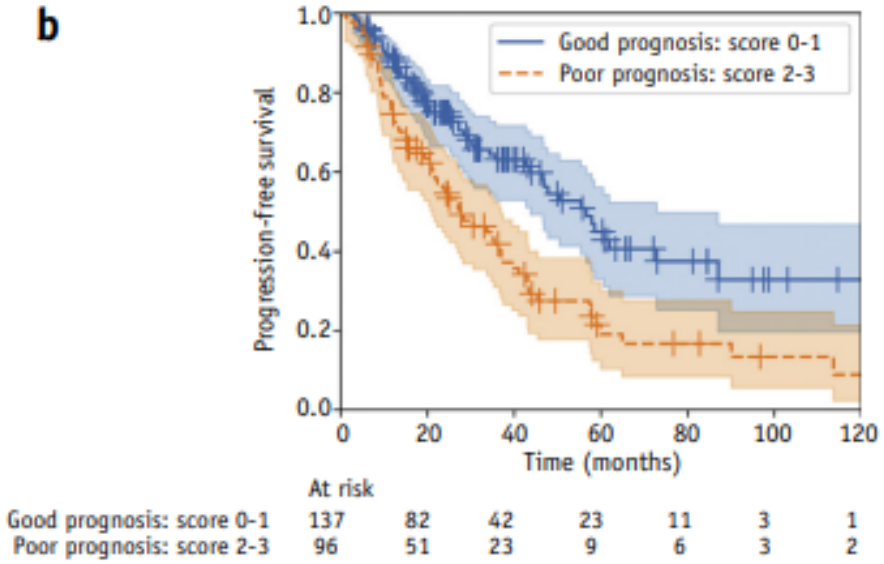
- Overall **5-year survival was 76.9%** and **43.3%** among patients with WHO grades **II and III** meningiomas, respectively.
- **Adjuvant RT** correlated with **improved survival** in a multivariable model in patients with **grade II** tumors (p = 0.029)

Alfredo Quinones Hinojosa J Neurooncology **2020**

Selection of pts Grade II meningioma for **SRS (adjuvant or definitive)**

Stratifications of the cohort





International Journal of Radiation Oncology biology • physics
www.redjournal.org

Clinical Investigation

Treatment of WHO Grade 2 Meningiomas With Stereotactic Radiosurgery: Identification of an Optimal Group for SRS Using RPA

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SRS is a good choice for **patients age<50**, **up to 1 previous resection**, **no previous RT (+ Volume<11.5cc)**

Kowalchk et al. USA Red Journal **Jan 2021**

Factors affecting SRS outcomes

factors associated with **improved SRS local control**

Statistically significant (P < .05) factors associated with improved SRS local control outcomes were:

- higher marginal **dose**,
- small- to medium-**sized** tumors,
- WHO **grade I**,
- **upfront SRS** (irradiated tumor without surgical resection),
- **early SRS** (cranial deficits < 1 yr),
- **female sex**,
- younger **age**,
- **less conformal** plans

ISRS

ISRS guidelines

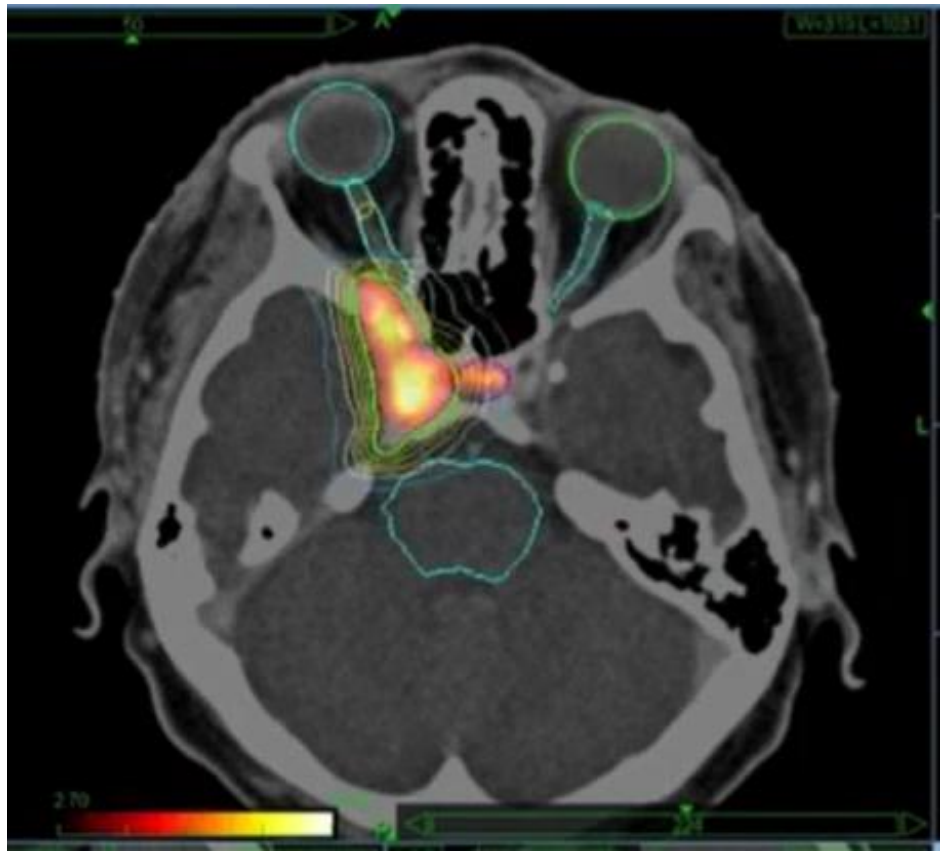
Multivariate analysis of **factors** associated with **improved local control** after **SRS**
(stable and reduced volume)

- Center experience (**CS**)
- Female (**CS,CP**)
- meningiomatosis vs sporadic (**CS, PC**)
- Prescription dose (**PC**)
- Maximum dose (**CP**)

- Cavernous sinus
- CerebroPontal Angle
- Petro clival

Santacrose et al. Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients **2011**

IMAGING: impact of ^{68}**Ga-DOTATOC PET to SRS** on target volume delineation of meningiomas



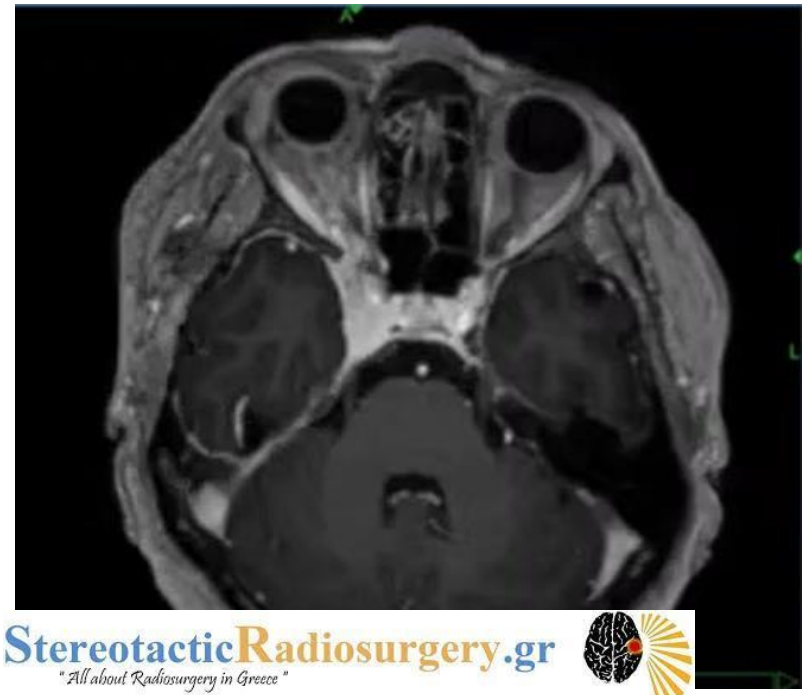
NEUROSURGICAL FOCUS
Neurosurg Focus 46 (6):E9, 2019

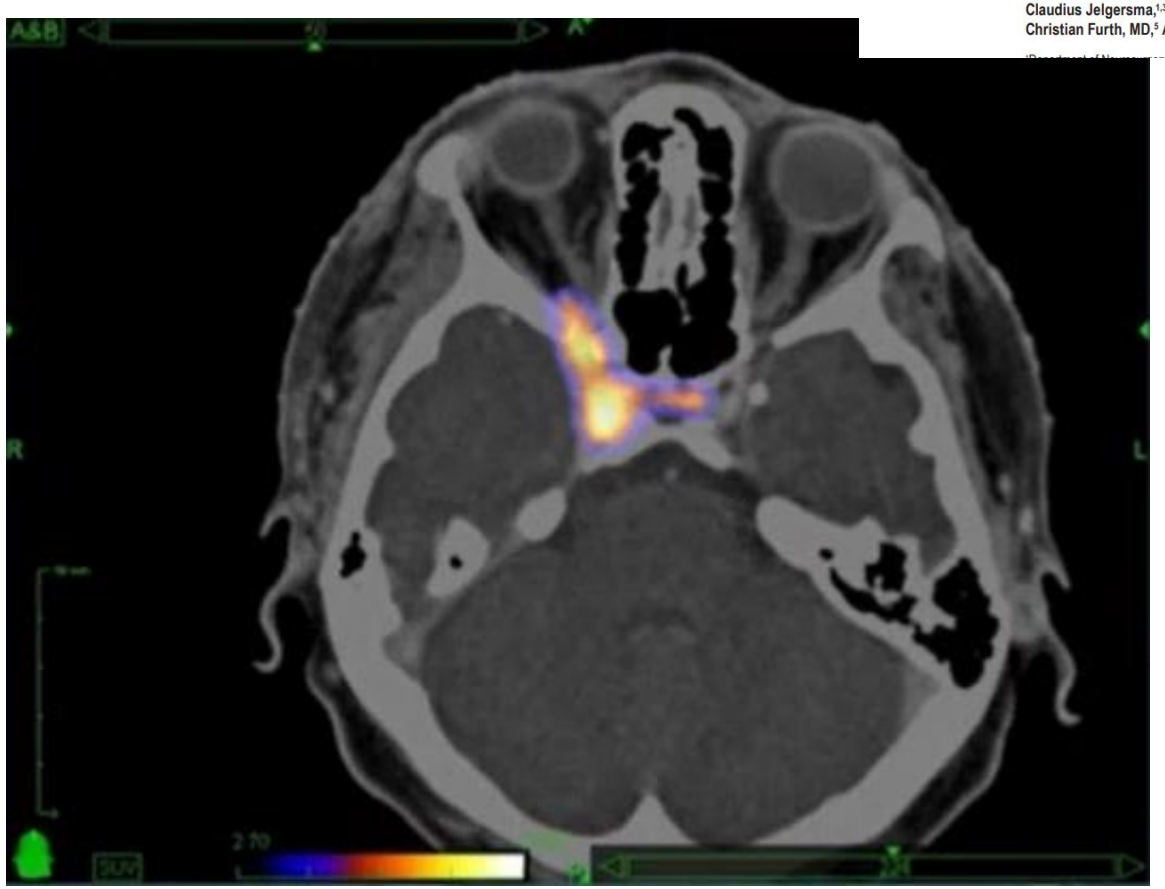
Impact of ^{68}Ga-DOTATOC PET/MRI on robotic radiosurgery treatment planning in meningioma patients: first experiences in a single institution

*Güliz Acker, MD,[1–3] Anne Kluge, PhD,[3,4] Mathias Lukas, MSc,[5] Alfredo Conti, MD, PhD, FEBNS,[1,3,6] Diana Pasemann, MSc,[3,4] Franziska Meinert,[1,3] Phuong Thuy Anh Nguyen,[1,3] Claudius Jelgersma,[1,3] Franziska Loebel, MD,[1,3] Volker Budach, MD,[3,4] Peter Vajkoczy, MD,[1,3] Christian Furth, MD,[5] Alexander D. J. Baur, MD,[5] and Carolin Senger, MD[3,4]

- **Easier to define target**
- **planning volumes showed significantly smaller** per physician
- **preference for PET/MRI** by **radiosurgeons** (particularly in proximity to critical structures)

Acker, Neurosurgical Focus (JNS) **2019**





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Acker, Neurosurgical Focus (JNS) **2019**

Skullbase meningioma Radiosurgery Complications

Complications SRS for Skullbase Meningiomas

- Neuropathy
- Optic pathway toxicity
- Facial Nerve toxicity
- Radiation Necrosis Brain
- Oedema
- Pituitary gland hormone deficit
- Headache

neurological deterioration

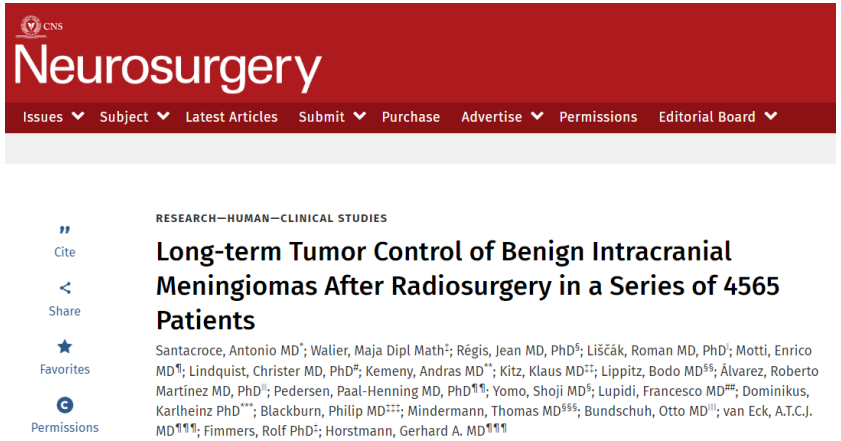
ISRS
International Stereotactic Radiosurgery Society

- Incidence of **neurological deterioration**, or development of **new neurological deficits** in those series with long-term follow-up, has been relatively **low**.

- Approximately **80%** to **100%** of patients **preserve neurological functions**

ISRS guidelines

complications


Neurosurgery

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RESEARCH—HUMAN—CLINICAL STUDIES

Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients

Santacroce, Antonio MD[*]; Walier, Maja Dipl Math[‡]; Régis, Jean MD, PhD[§]; Liščák, Roman MD, PhD[‖]; Motti, Enrico MD[¶]; Lindquist, Christer MD, PhD[#]; Kemeny, Andras MD[**]; Kitz, Klaus MD[‡‡]; Lippitz, Bodo MD[§§]; Álvarez, Roberto Martínez MD, PhD[‖]; Pedersen, Paal-Henning MD, PhD[¶¶]; Yomo, Shoji MD[§]; Lupidi, Francesco MD[##]; Dominikus, Karlheinz PhD[***]; Blackburn, Philip MD[‡‡‡]; Mindermann, Thomas MD[§§§]; Bundschuh, Otto MD[‖‖]; van Eck, A.T.C.J. MD[¶¶¶]; Fimmers, Rolf PhD[‡]; Horstmann, Gerhard A. MD[¶¶¶]

Neurological deterioration

- **CS 10.8%**
- PC 15%
- CPA 14.2%

Permanent morbidity rates

CS 5.9%

PC 8.4%

CPA 8.3%

StereotacticRadiosurgery.gr
"All about Radiosurgery in Greece"

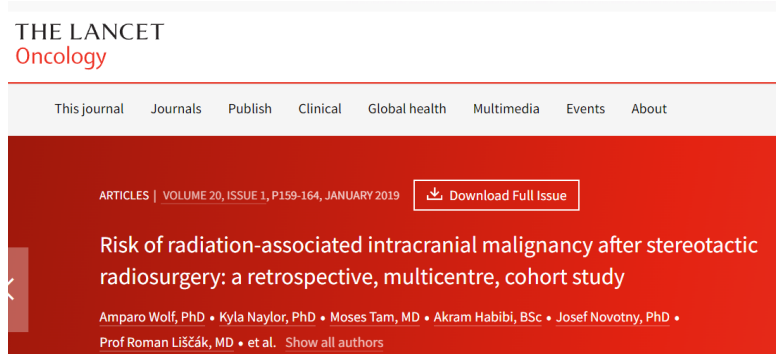
Santacrose et al. Long-term Tumor Control of Benign Intracranial Meningiomas After Radiosurgery in a Series of 4565 Patients 2011

Post-SRS **Edema**

- **Skullbase** meningiomas **lower risk** of post-SRS edema
- Edema is related with **Dose** and **Volume**
- Edema is NOT DIRECTLY RELATED with Dose and Volume

Multivariate mechanism with unclear relationship

Risk of **radiation-associated intracranial malignancy** after **stereotactic radiosurgery**: a retrospective, multicentre, cohort study



6·87 per 100 000 patient-years for malignant transformation
2·26 per 100 000 patient-years for radiosurgery-associated intracranial malignancy

- estimated risk for **intracranial secondary malignancy** or **malignant transformation** of a benign tumour in patients treated with **stereotactic radiosurgery** remains low at long-term follow-up
- **similar to the risk** of the general population to have a **primary CNS tumour**

StereotacticRadiosurgery.gr
"All about Radiosurgery in Greece"

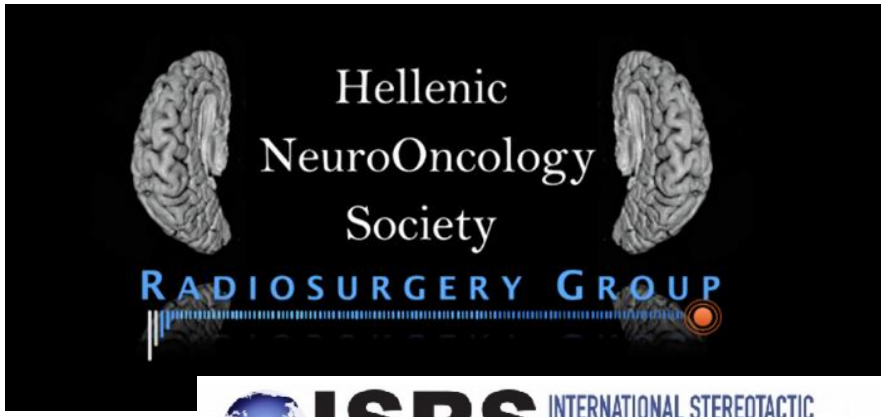
https://sci-hub.se/10.1016/

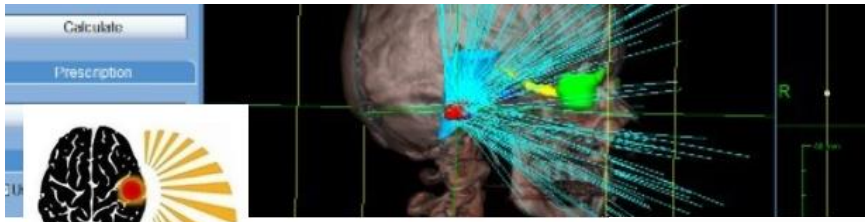
Douglas Kondjiolka et al, Lancet 2018

“Stereotactic Radiosurgery”

“Stereotactic Radiosurgery”

- **Dedicated** in SRS
- International **SRS Training and Practice** 2006
- International **SRS Certification** 2010
- Establish **“SRS Group”** of Hellenic Neuro-Oncology Society 2017
- Establish Greek **Radiosurgery Guidelines** 2019
- **Affiliated ISRS members** of 2020
- **Linkedin** “Stereotactic Radiosurgery” (8500 members) 2021
- Represented in **Radiosurgery Board** 2021
  - Greek Ministry of Health
  - Greek Public Insurance (EOPYY)





Stereotactic Radiosurgery

"...About Radiosurgery around the World..."

Hospitals and Health Care · Chalandri, Attica · 8K followers · 2-10 employees

StereotacticRadiosurgery.gr

"All about Radiosurgery in Greece"

Operating systems

- **Radiosurgery (isocentric) THESSALONIKI**
- Robotic Radiosurgery (non isocentric) ATHENS

St. LUKE'S HOSPITAL

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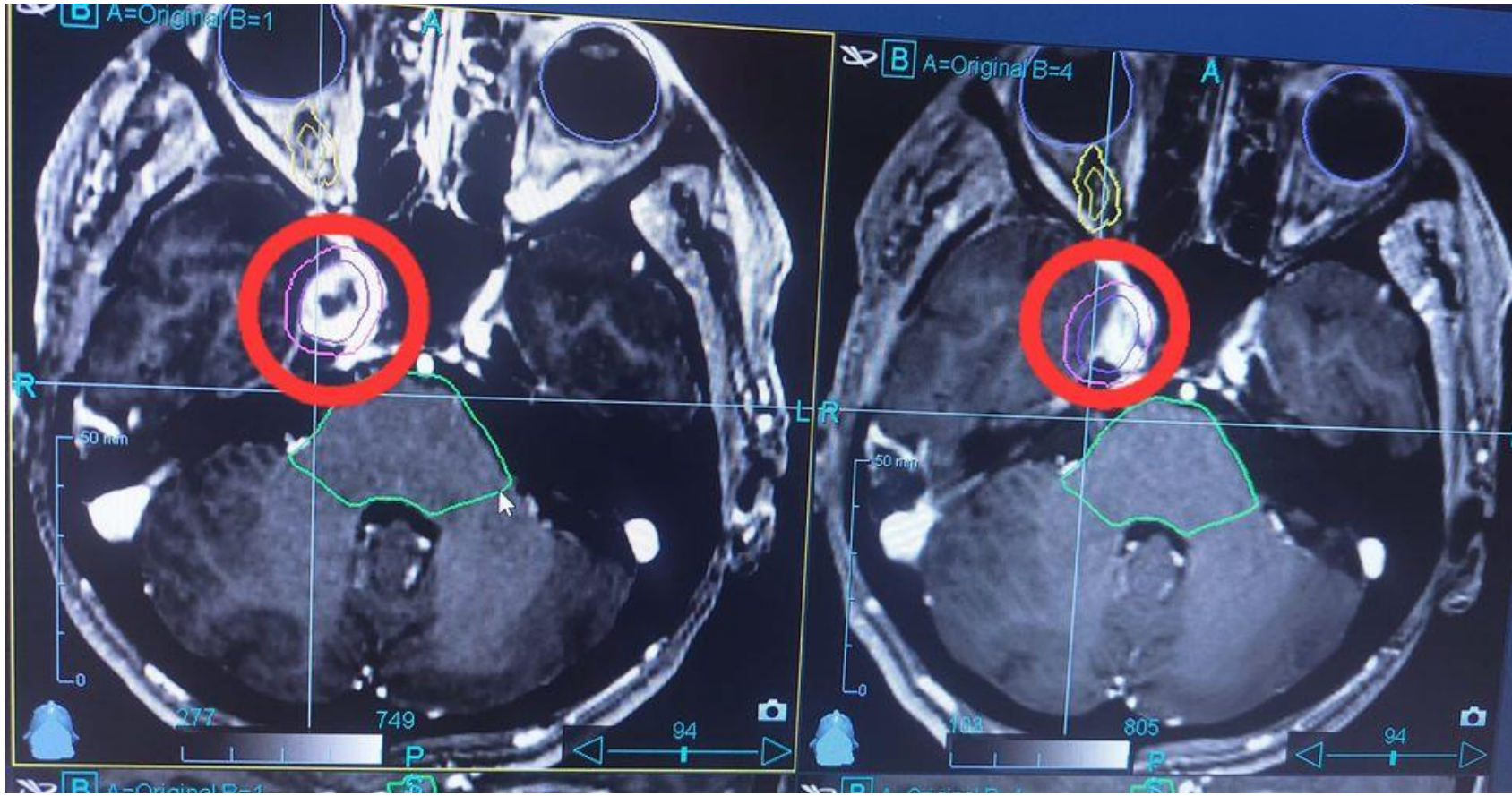
Case 1

Cavernous Sinus Meningioma treated with SRS

- Response after 3 years
- **Tumor Necrosis** and **Shrinkage**



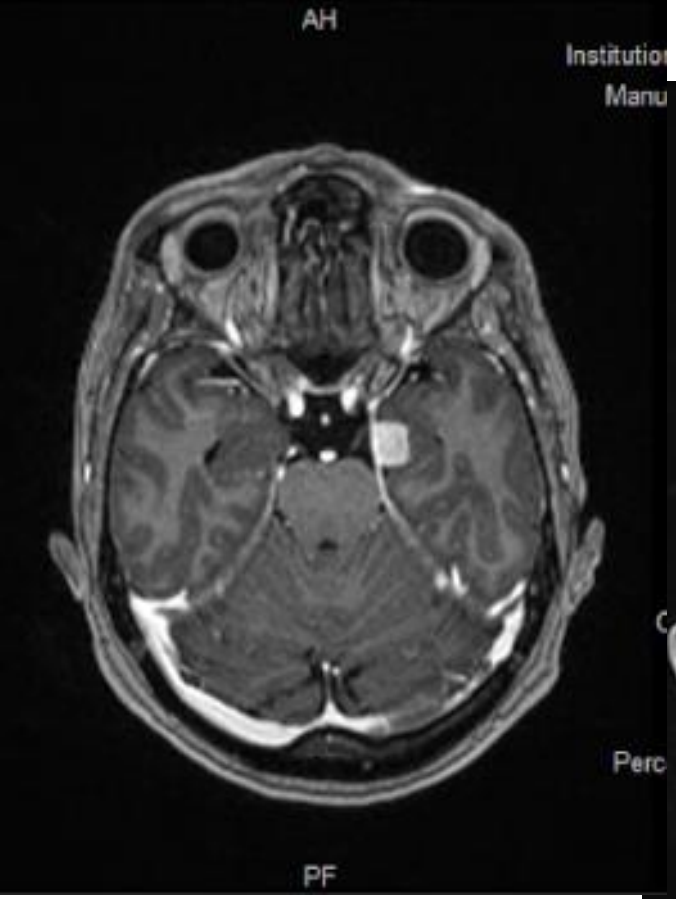
Case 2

Meningioma treated with SRS

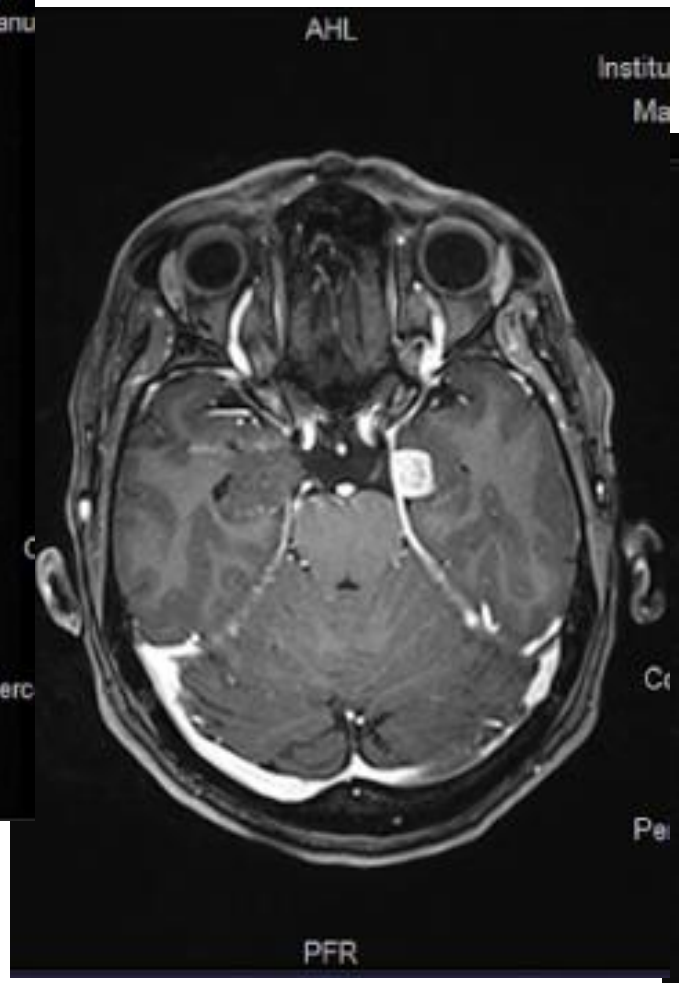
Female 52 yrs
Meningioma
Initial enlargement and **Delay Response** after SRS

6months: enlargement

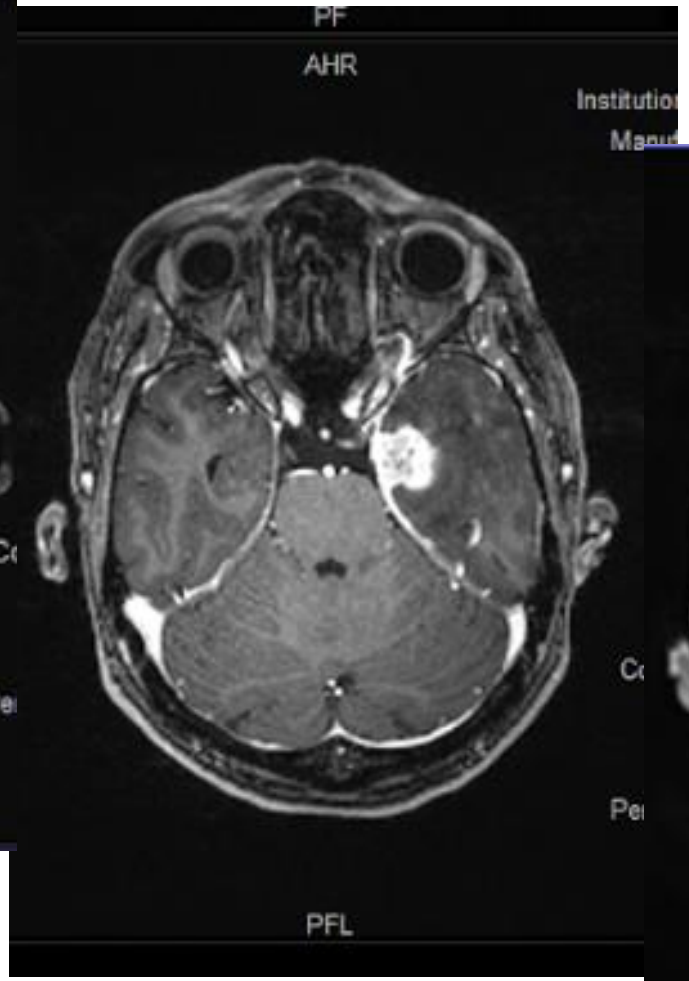
12 months Shrinkage



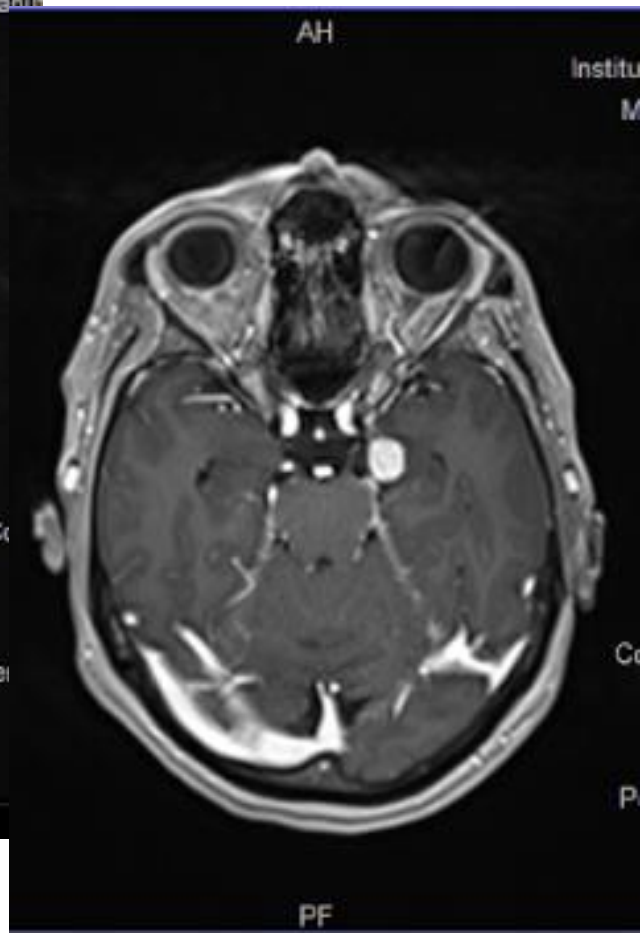
Sep 2022 SRS



Nov 2022, 2 Months

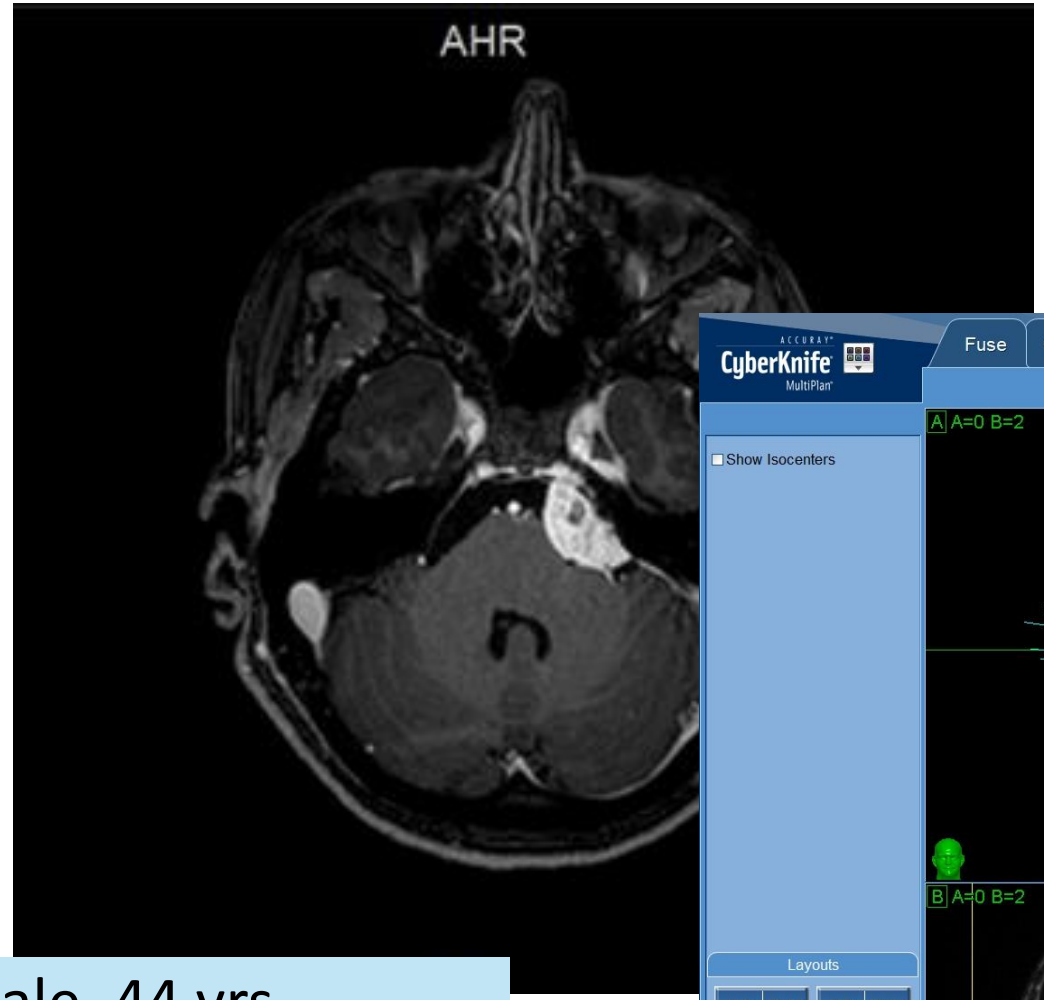


Apr 2023, 6 Months

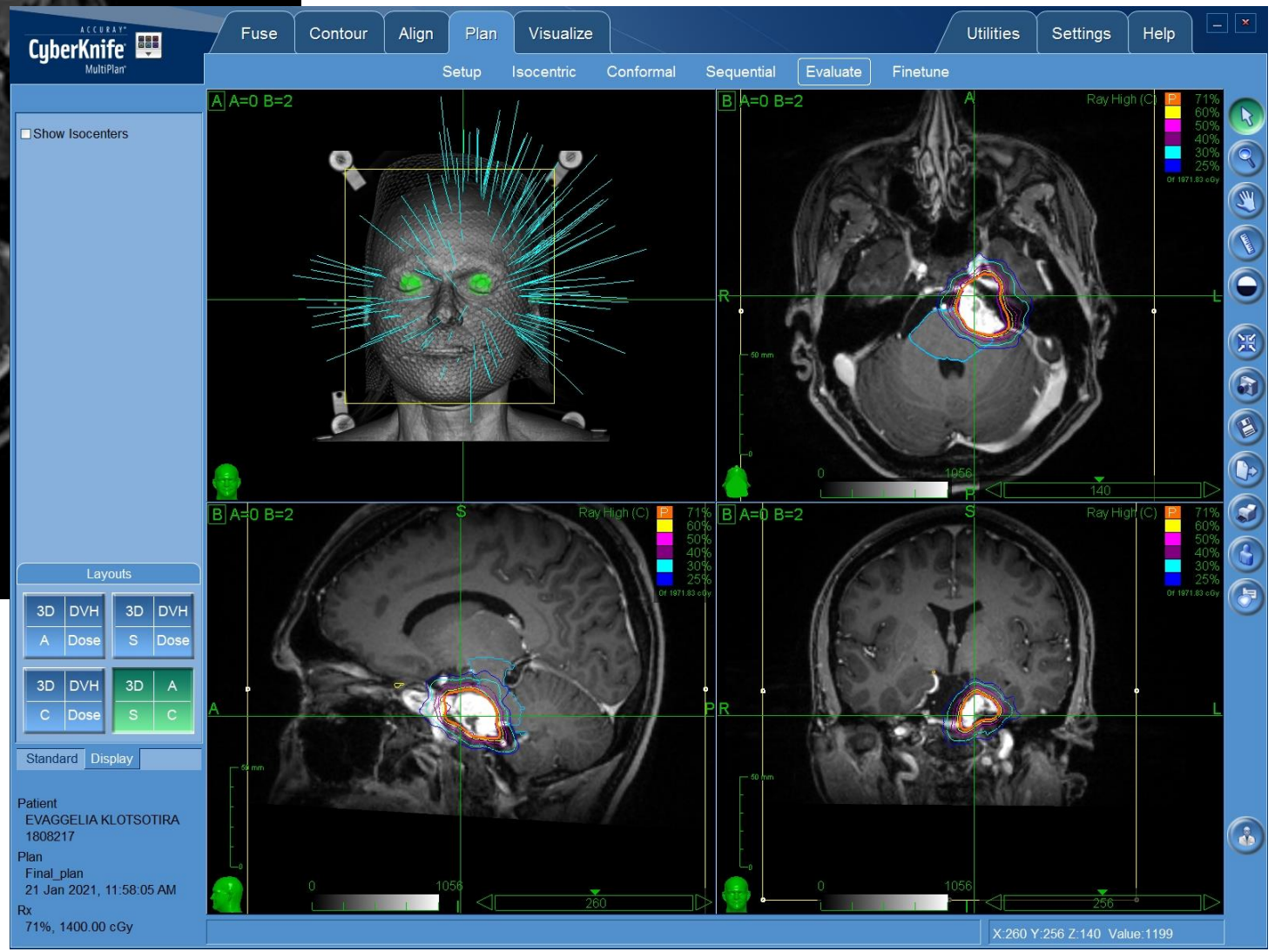


Sep 2023, 12 Months

Case 3



Jan 2021: SRS



Female, 44 yrs

mild deficit ocular motor

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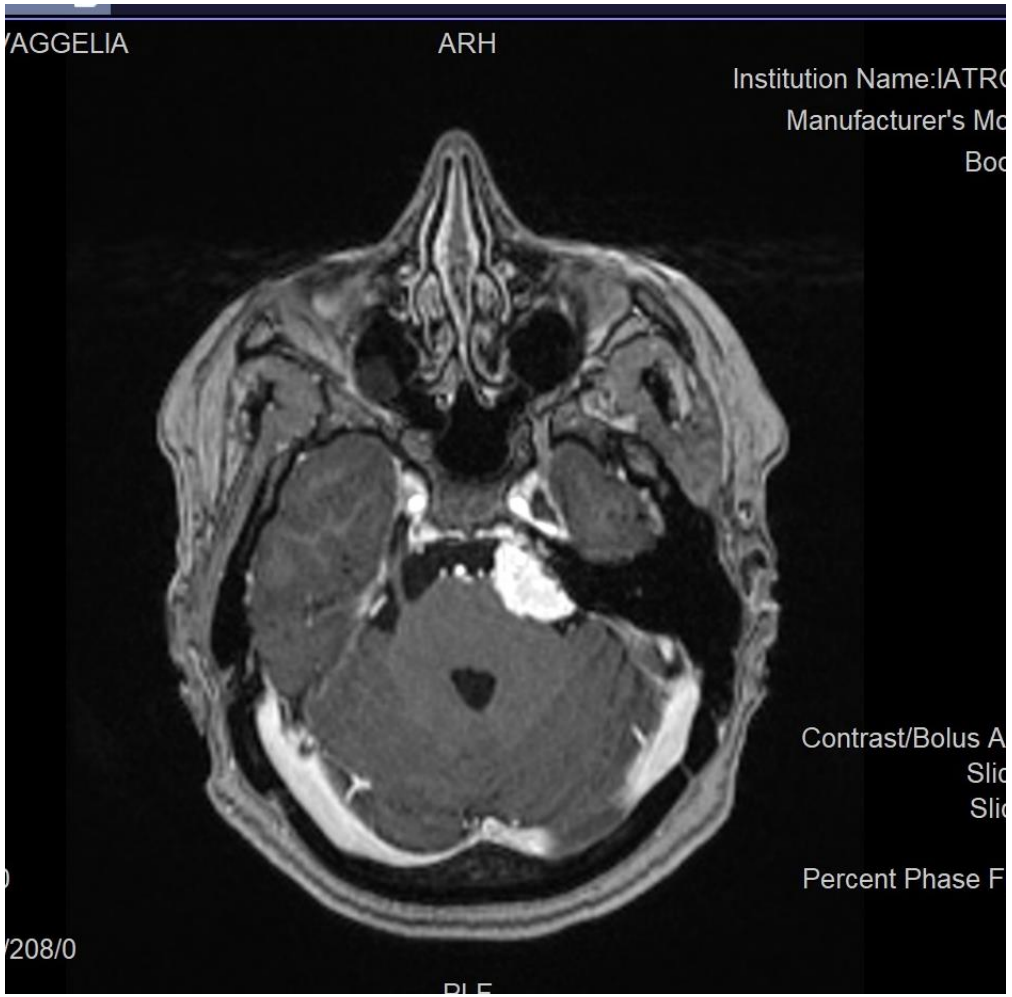
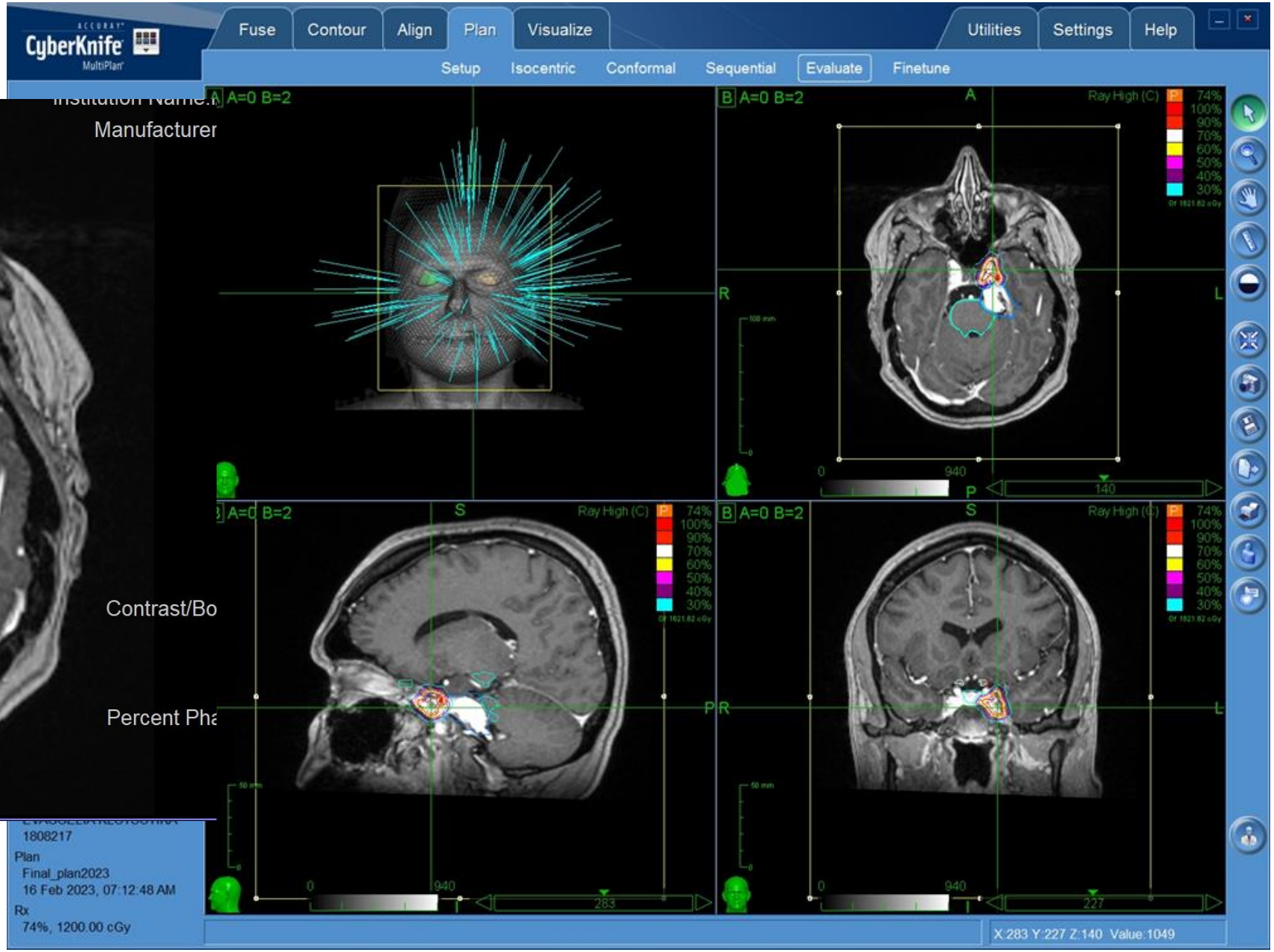
Jan 2021: SRS

Feb 2023: Response

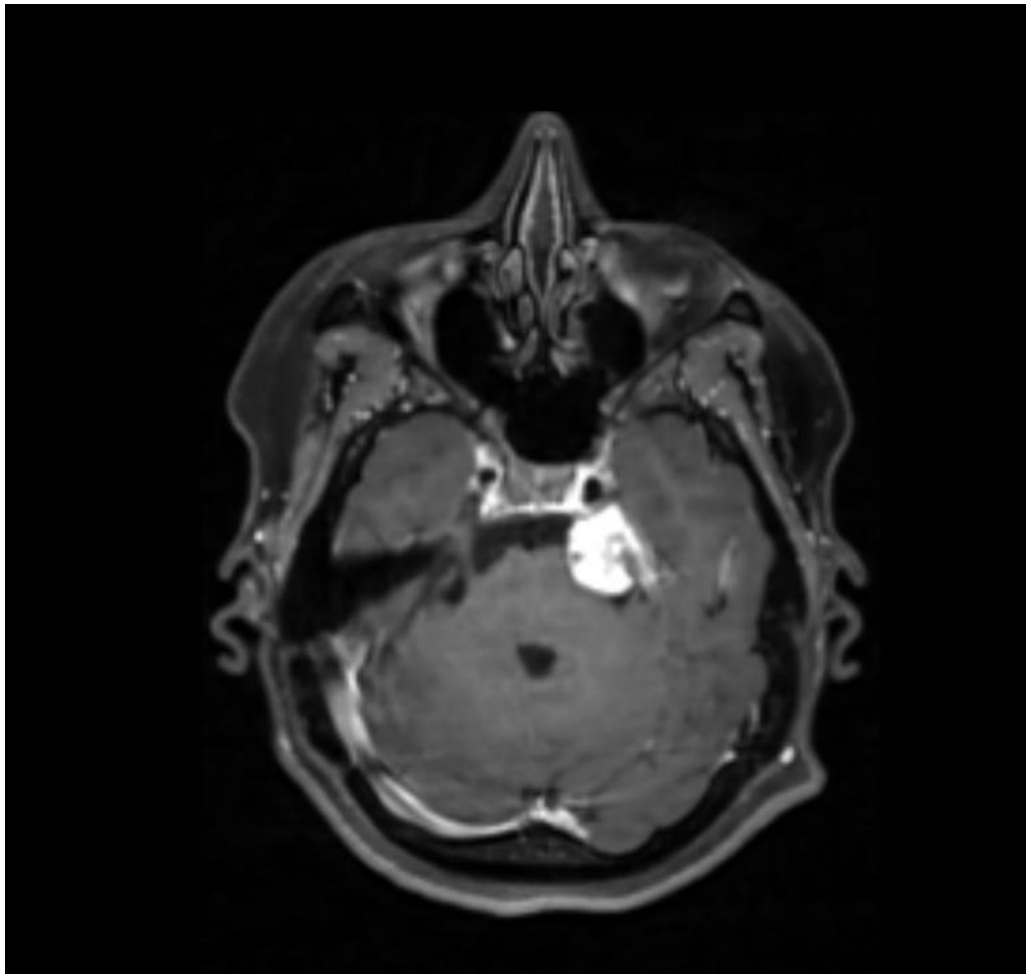


Relapse - Feb 2023 (2nd SRS)



Relapse - Feb 2023

Local Control Aug 2024



Conclusions

- Radiosurgery is a **safe** and **efficient** therapy for skullbase meningioma
- high rate of **tumor response** and **neurological improvement**
- Low rates of **complications**
- **Molecular** and **Genetic profile** of the tumor is a challenge for better outcomes
- **Modern imaging** is a precious tool
- Selection of the proper **Dose** is crucial

THANKS!

OUR TEAM

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