



#SEN.R2024

Reunión Anual
**SOCIEDAD ESPAÑOLA DE
NEURORRADIOLOGÍA**

7 - 9 de noviembre de 2024 • SAN SEBASTIÁN

SEDE: Hotel Barceló Costa Vasca

**Protonterapia: indicaciones,
seguimiento radiológico y
complicaciones**

Víctor M Suárez Vega, MD, PhD,
Clínica Universidad de Navarra, Campus Madrid



El puente conecta dos orillas,
la imagen cerebral une la mente y la ciencia

*Zubiak aldeak lotzen ditu;
garun-irudiak, adimena eta zientzia*





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SAN SEBASTIÁN

7 - 9 de noviembre de 2024



No conflictos de interés





ESQUEMA

- INDICACIONES
- PLANIFICACION / SEGUIMIENTO
- COMPLICACIONES (CASOS)



A light gray drawstring bag is shown against a white background. The bag is slightly wrinkled and has two small metal grommets at the bottom corners. Overlaid on the bag is a list of medical and scientific terms in a bold, orange, sans-serif font. The text is arranged in six lines, slanted upwards from left to right.

VOLUMETRÍA 3D
BASE CRÁNEO
TUMORES PEDIÁTRICOS
RICE RADIONECCROSIS
PICOS BRAGG
BENEFICIO DOSIMÉTRICO



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DEFINICIÓN



- Haz de **protones** en vez de un haz de *fotones* (radioterapia convencional)



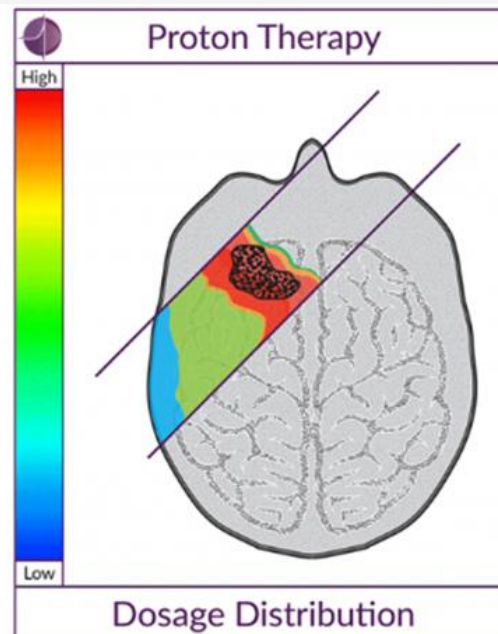
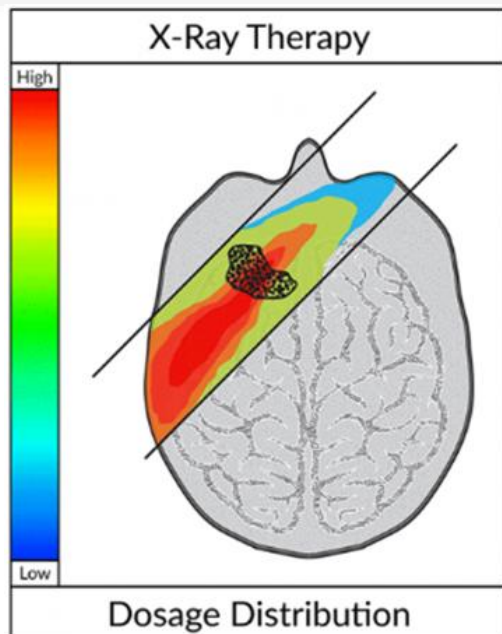
Menor toxicidad



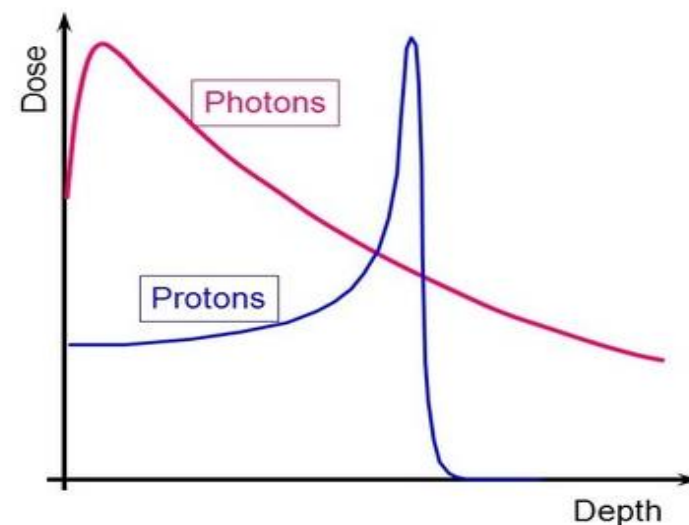
Mayor precisión



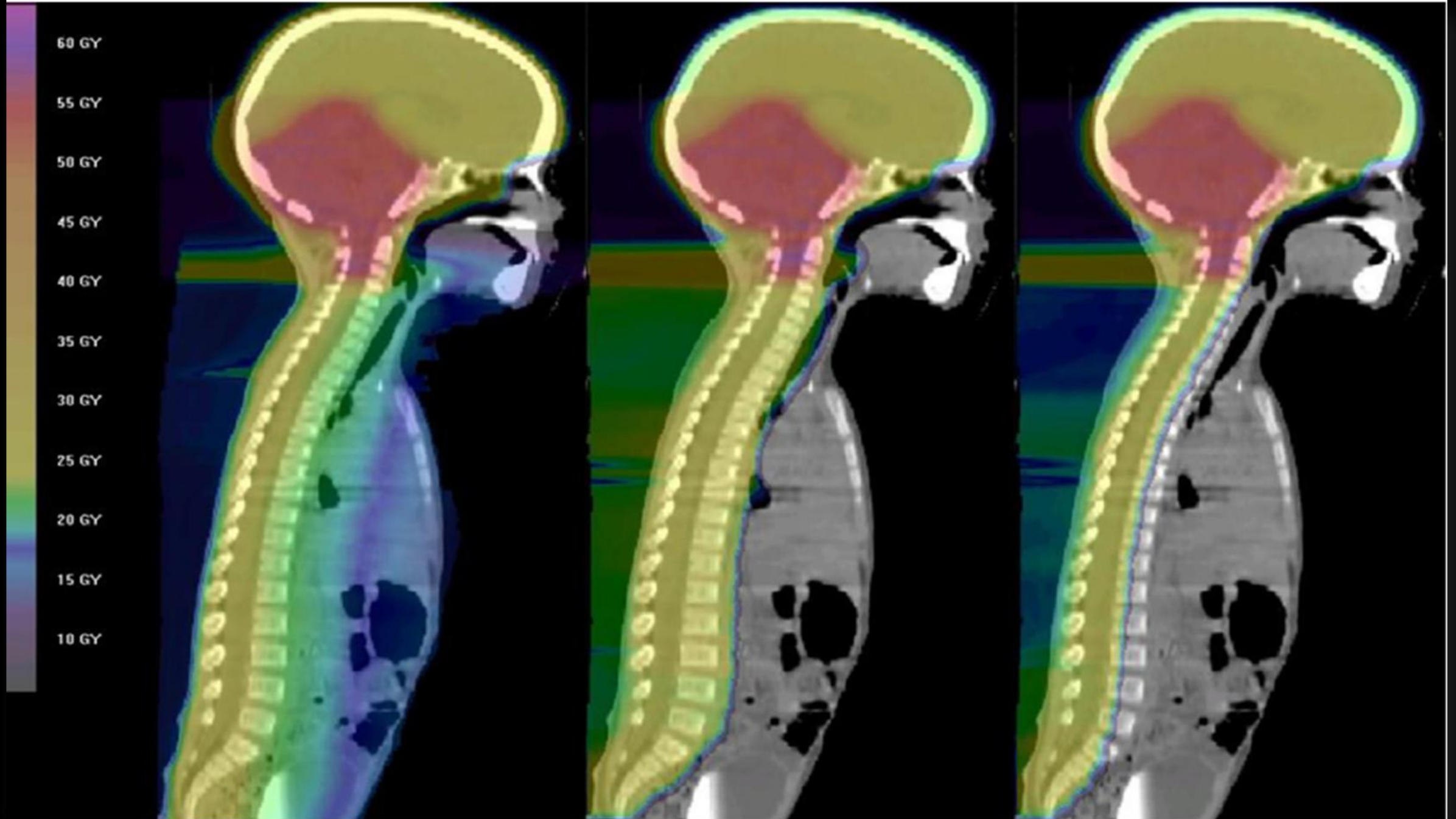
Mayor control

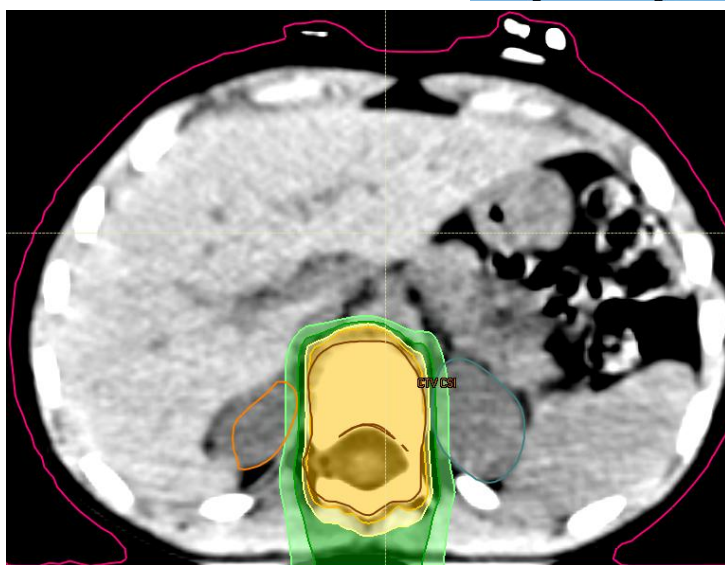
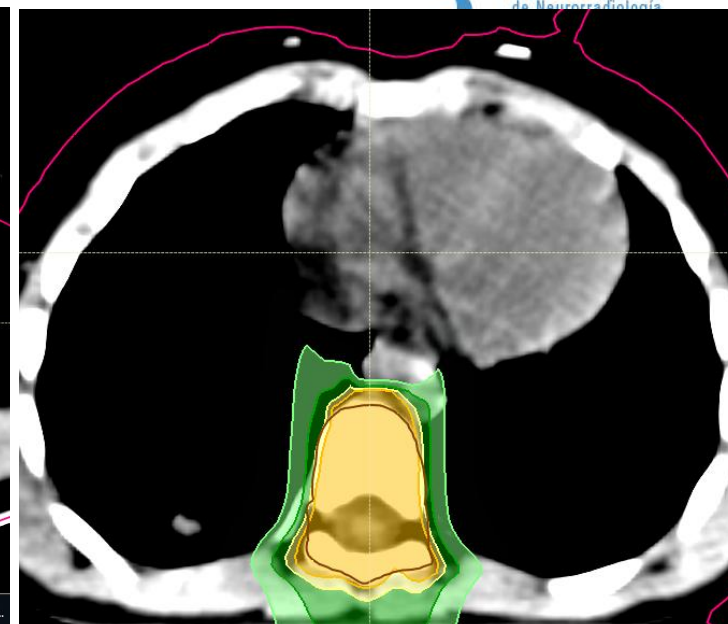
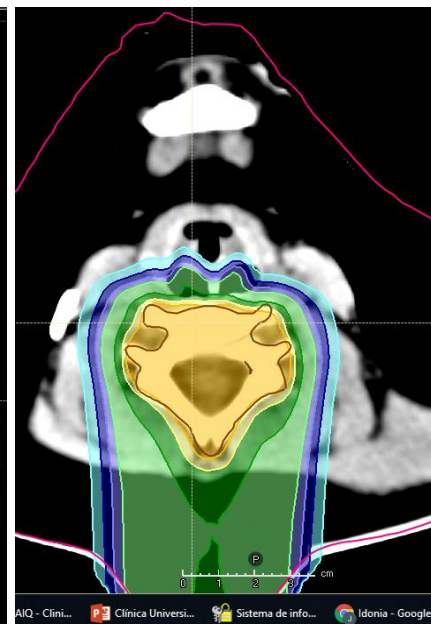
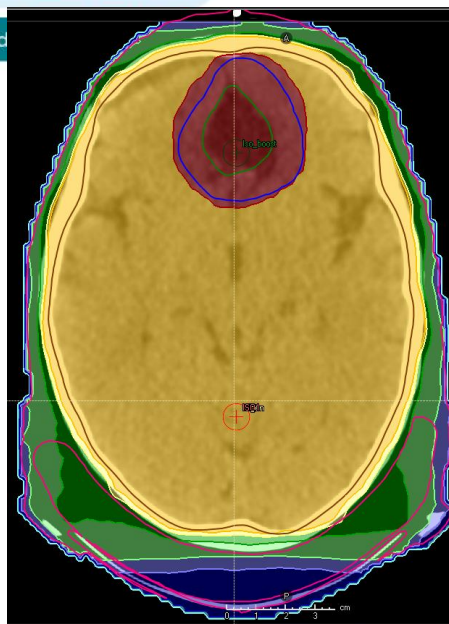
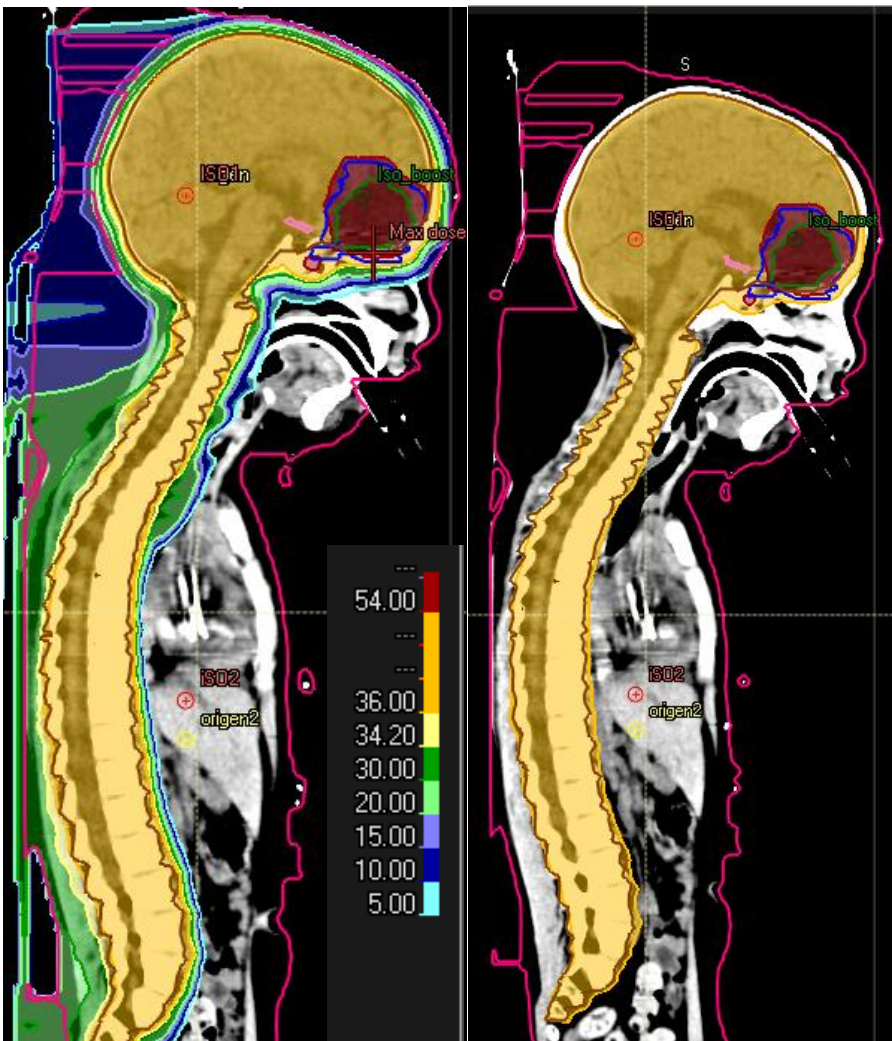


Bragg peak







ATRT supratentorial
(4 años)

Cortesía Dr. Aristu, Unidad Protonterapia, CUN Madrid



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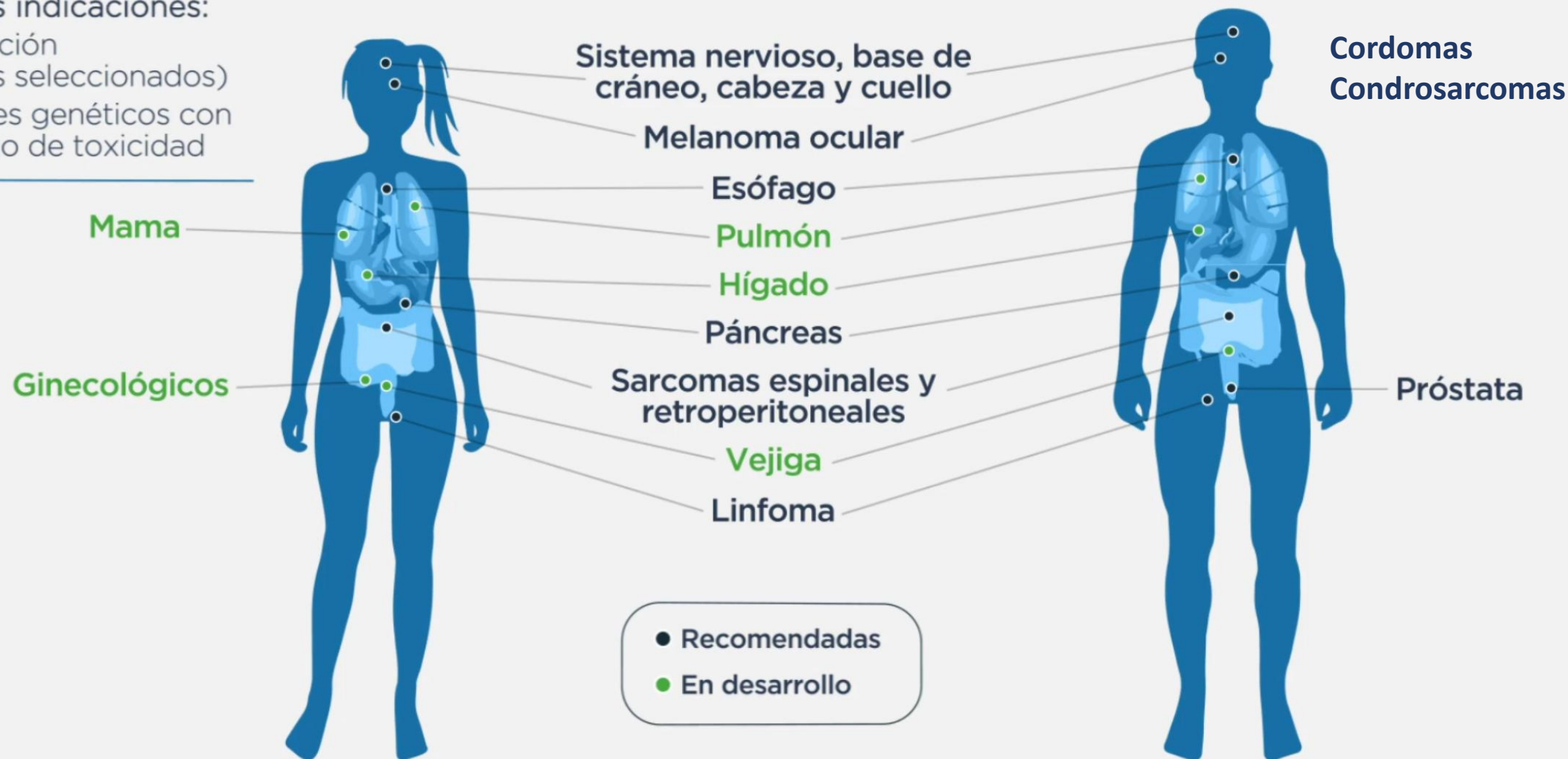


INDICACIONES



Principales indicaciones:

- Reirradiación (en casos seleccionados)
- Síndromes genéticos con alto riesgo de toxicidad



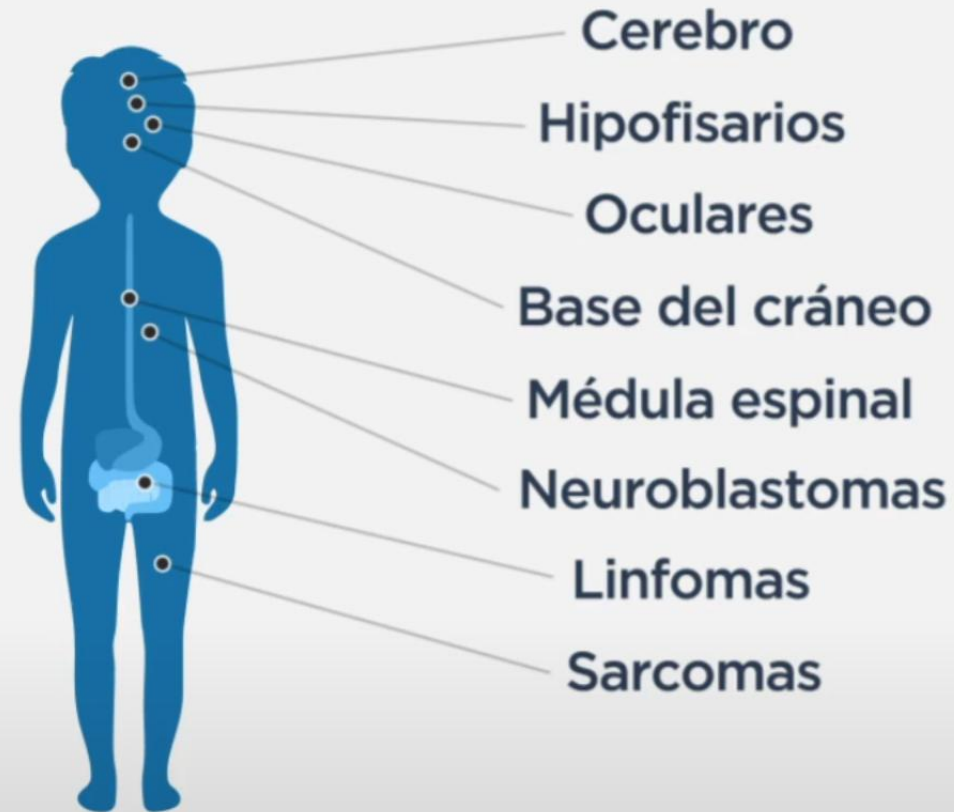
Modalidad de tratamiento que mejor preserva los tejidos sanos

* Según el consenso entre las sociedades científicas norteamericanas (ASTRO), española (SEOR) y japonesa (JASTRO) para la recomendación del tratamiento de protonterapia en estos tipos de tumores.

En niños, es el tratamiento de elección para los tumores susceptibles de ser tratados con radioterapia externa.

Principales indicaciones:

- Reirradiación
(en casos seleccionados)
- Síndromes genéticos con
alto riesgo de toxicidad



Las ventajas de la protonterapia en los niños

Modalidad de tratamiento que mejor preserva los tejidos sanos y reduce los efectos adversos en órganos y sistemas en proceso de crecimiento

4 AÑOS DE ACTIVIDAD DE LA Unidad de Protonterapia



Clínica
Universidad
de Navarra



Cancer
Center

S.E.N.R.
Sociedad Española
de Neurorradiología

PACIENTES
TRATADOS **872**

520 hombres y **352** mujeres
Menores de 18 años: **266**



Tratamientos
finalizados: **846** Tratamientos
en curso: **26**

TUMORES **24** tipos de tumores
diferentes:

Astrocitoma
Base de cráneo
Condrosarcoma
Cordomas
Craneofaringiomas
Ependimoma
Esófago

Ginecológicos
Gliomas
Hepatocarcinoma
Hipófisis
Mama
Meduloblastomas
Nasofaríngeos

Oligometástasis
Órbita
Para-espinales
Próstata
Pulmón
Rabdomiosarcoma
Recto

Reirradiaciones
Sarcoma cerebral
Sarcoma de
partes blandas



Localizaciones
de los tumores

Abdomen **51**
Cabeza y cuello **239**
Craneoencefálico **278**

Espinales **18**
Extremidades **32**
Mama **29**

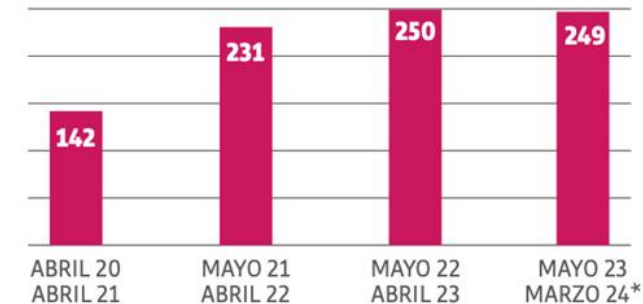
Pelvis **155** (Próstata **94**)
Torácico **70**

26

países de 4
continentes



PACIENTES
POR PERIODOS



Cortesía Dr. Aristu, Unidad Protonterapia, CUN Madrid MARZO 2024

... 2023 statistics CUN proton therapy activity... for PTCOG website



254

Pediatric 83

CNS 80

H&N 38

Thorax 10

Breast 16

Prostate 31

Sarcoma 63

GYN 3

GI 15

Lymphoma 1

reRT 37

Today 25.09.2024
starts patient # 959



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PLANIFICACION SEGUIMIENTO





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RayStation Doctor 12A SP1

Patient data management Patient modeling Plan evaluation

Image registration Structure definition

ROI tools POI tools Approval Fusion

Select layout Show fusion

Fusion type: Overlay Blend: Primary Secondary Flip pattern

Color scheme: None

Position: -3.78 30.19 25.71 cm
CT: 31 HU
SPR: 1.048

ROI

Targets (5)

- GTV-T1Gad+Lecho
- GTV-T2FLAIR
- CTV-2_54
- CTV-1_50
- CTV-3 PET_60

Organs at risk (22)

- Body
- External
- Brain
- Brainstem
- Chiasm
- Cochlea (Left)
- Cochlea (Right)
- Eye (Left)
- Eye (Right)
- Lens (Left)

Showing geometry status for: CT PL...

ROI material management

ROI/POI details

Primary: CT: CT PLANNING 08/10/2024
Secondary: MR: MR 5
Registration: Frame-of-reference registration
CTAWP105029
Transversal: 30.19 cm
Slice 122/198

RayStation Doctor 12A SP1

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Select layout Show fusion

Fusion type: Overlay Blend: Primary Secondary Flip pattern

Color scheme: None

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Secondary: MR: MR 5
Registration: Frame-of-reference registration
CTAWP105029
Transversal: 30.19 cm
Slice 122/198

RayStation Doctor 12A SP1

Patient data management Patient modeling Plan evaluation

Image registration Structure definition

ROI tools POI tools Approval Fusion

Select layout Show fusion

Fusion type: Overlay Blend: Primary Secondary Flip pattern

Color scheme: None

Position: 2.05 30.04 27.25 cm
CT: 40 HU
SPR: 1.054

ROI

Targets (5)

- GTV-T1Gad+Lecho
- GTV-T2FLAIR
- CTV-2_54
- CTV-1_50
- CTV-3 PET_60

Organs at risk (22)

- Body
- External
- Brain
- Brainstem
- Chiasm
- Cochlea (Left)
- Cochlea (Right)
- Eye (Left)
- Eye (Right)
- Lens (Left)

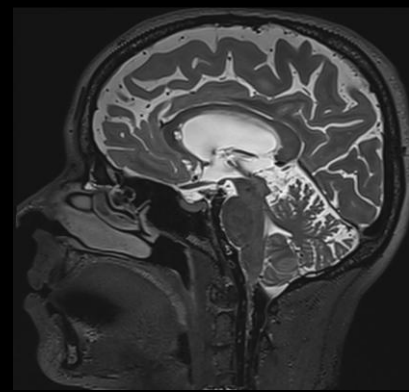
Showing geometry status for: CT PL...

ROI material management

ROI/POI details

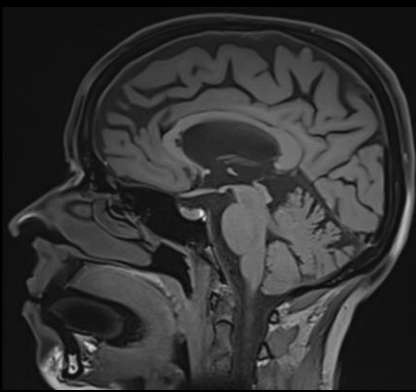
Primary: CT: CT PLANNING 08/10/2024
Secondary: MR: MR 3
Registration: Frame-of-reference registration
CTAWP105029
Transversal: 30.04 cm
Slice 121/198

GLIOMAS / SNC 3Tesla



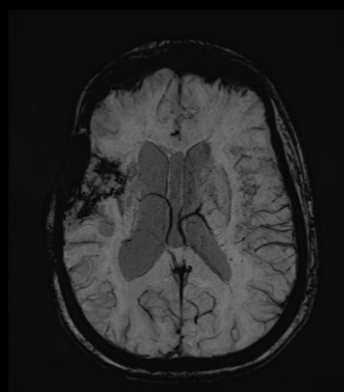
T2 SPACE 3D

3D
Multiplanar
Planificación



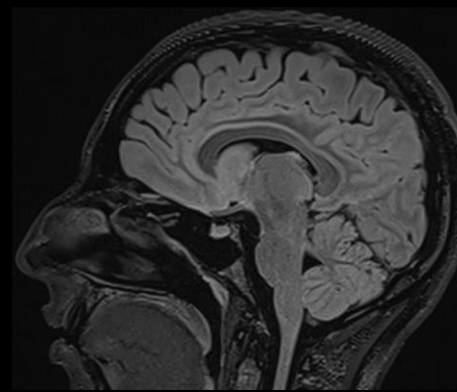
T1 SPACE pre Gd

3D
Multiplanar
HiperInt basales



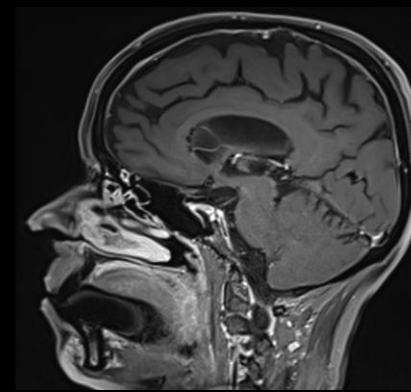
SWI

Micro
sangrados



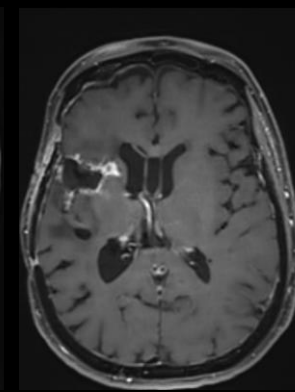
FLAIR 3D + Gd

Edema
Enfermedad no
captante
Leptomeningea

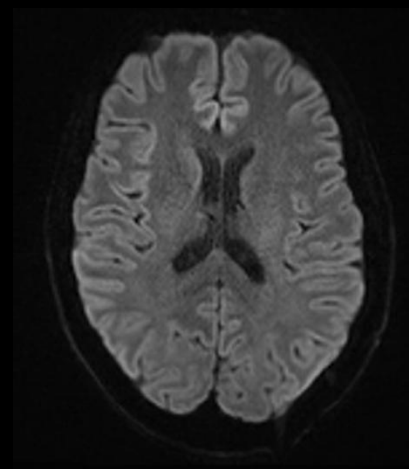


T1 SPACE Gd

Enfermedad captante

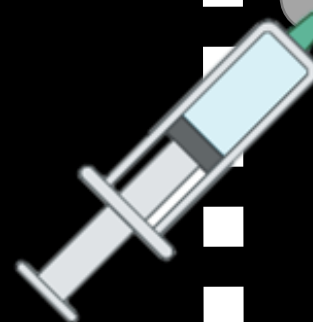


MPR Axial

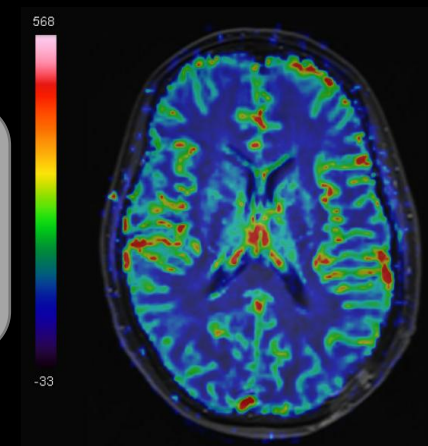


DWI b1000

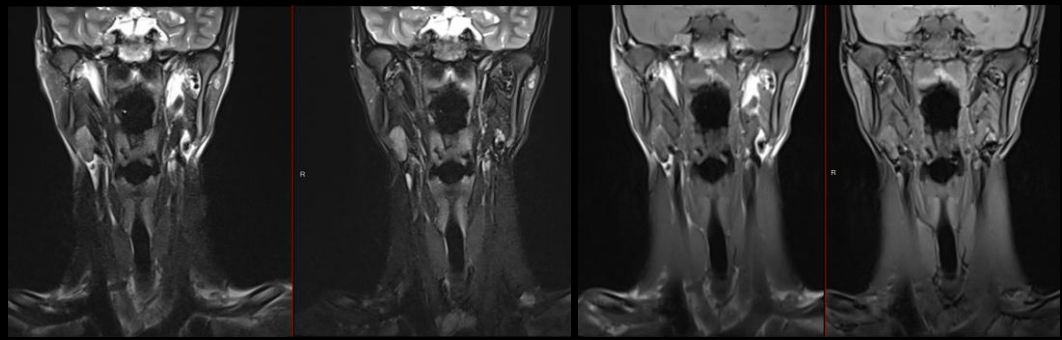
Hipercelularidad
Necrosis coagul



OPCIONAL
PERFUSIÓN T₂
CBV

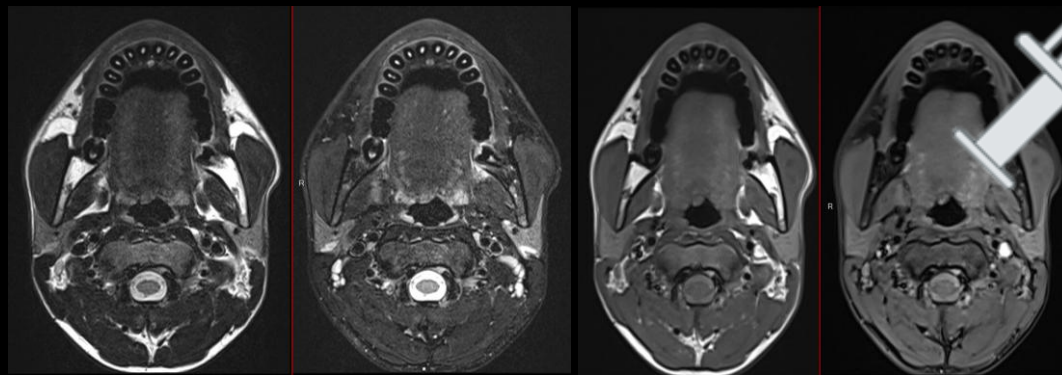


CABEZA Y CUELLO



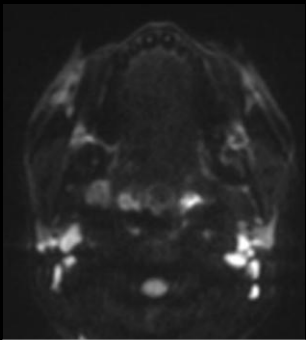
T2 DIXON COR

T1 DIXON COR

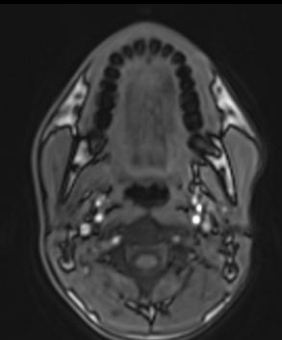


T2 DIXON AXIAL

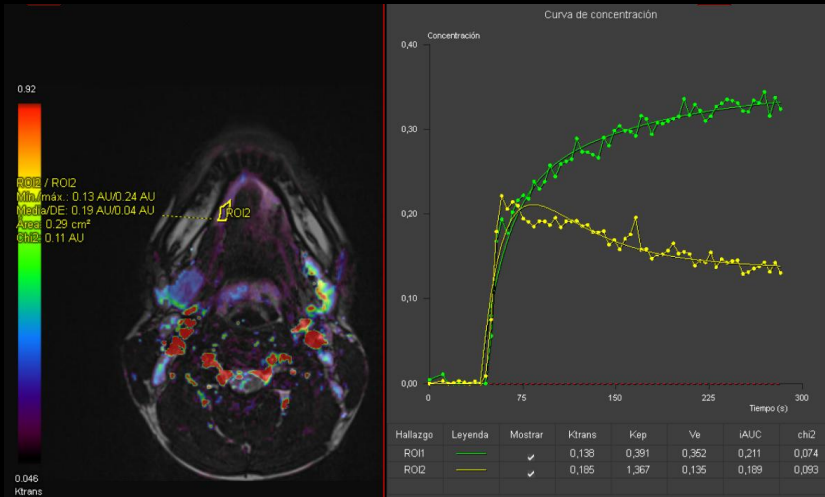
T1 DIXON AXIAL



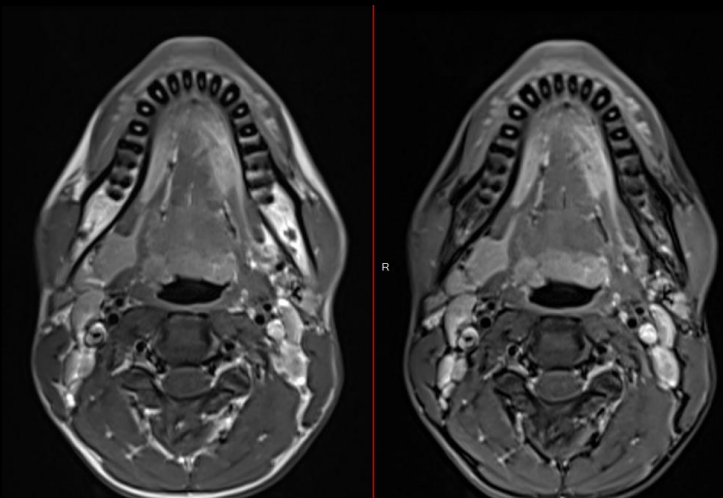
DWI



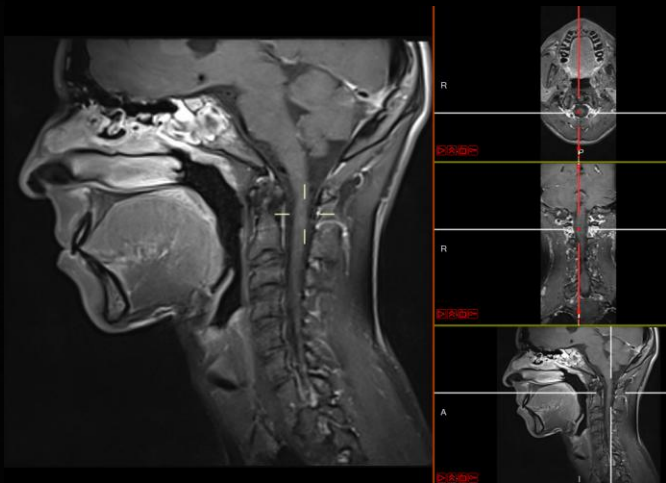
T1MAPPING



T1 PERMEABILIDAD KTRANS

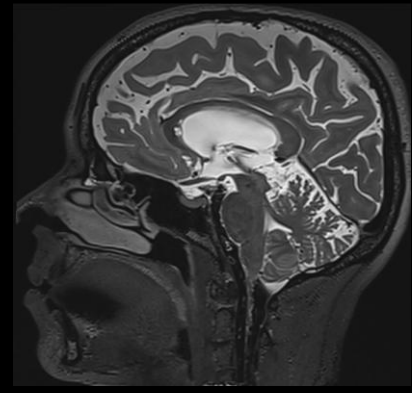


T1 DIXON AXIAL

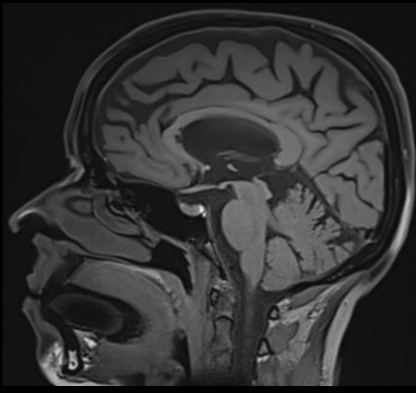


T1 SPACE SAG VOL

CRANEO-ESP (MÉDULOBLAST-EPENDIMOMA)



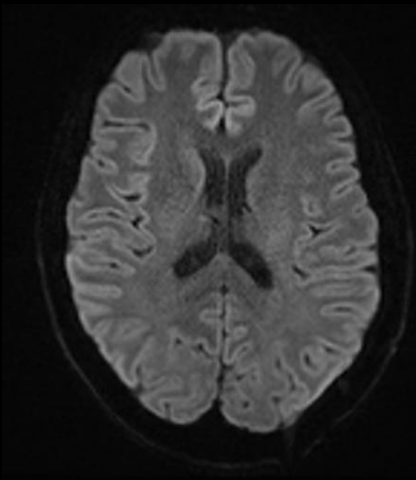
T2 SPACE 3D



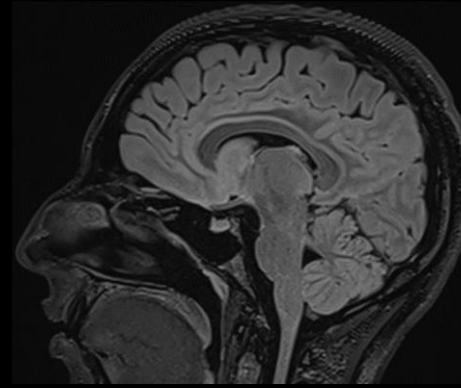
T1 SPACE pre Gd



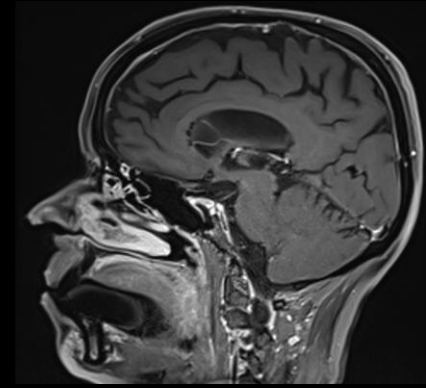
SWI



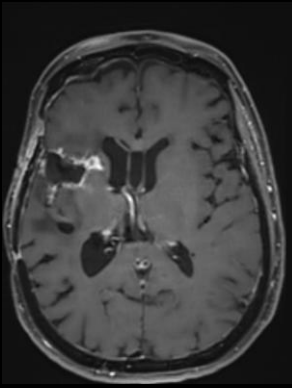
DWI b1000



FLAIR 3D + Gd



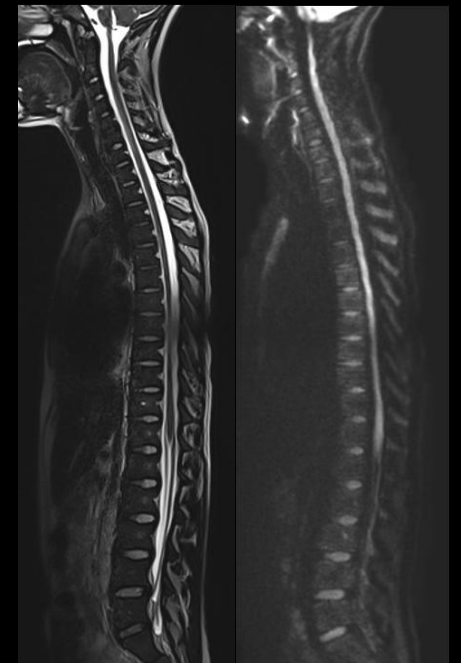
T1 SPACE Gd



MPR Axial



T1 DIXON SAG



T2 SPACE + DWI





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SOCIEDAD ESPAÑOLA DE
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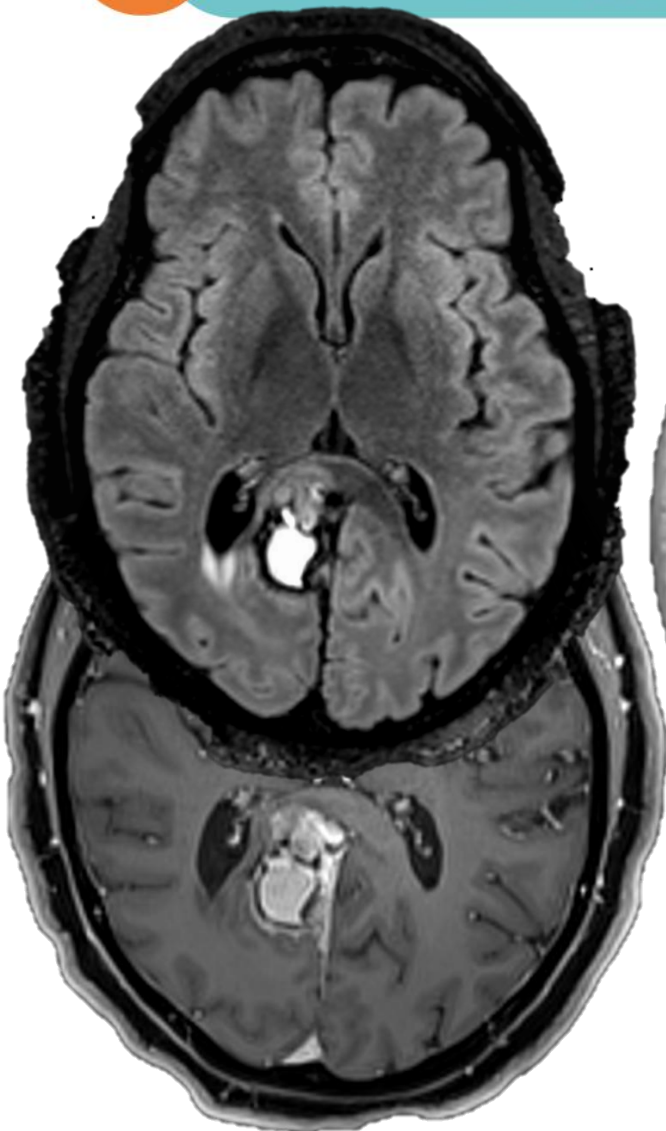
SAN SEBASTIÁN

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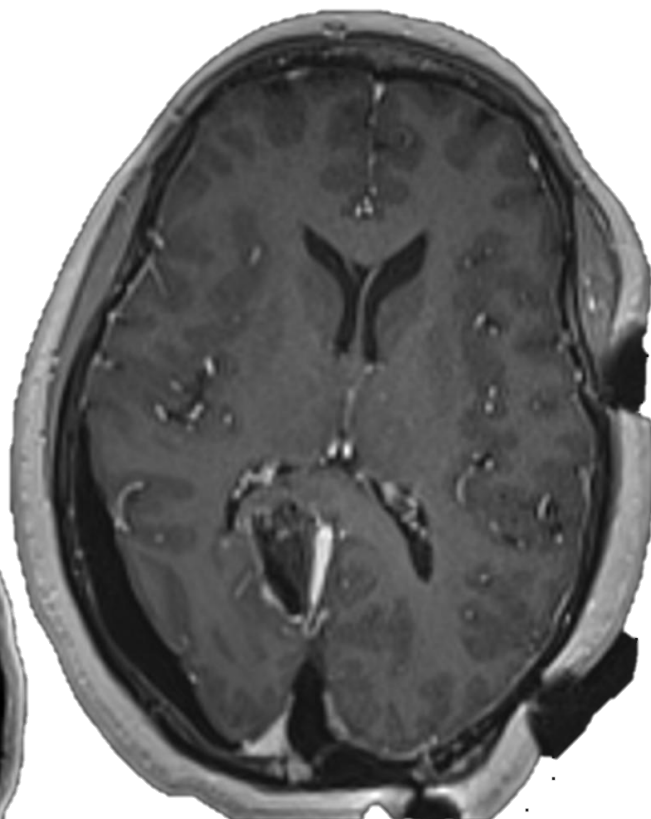


COMPLICACIONES (CASOS)



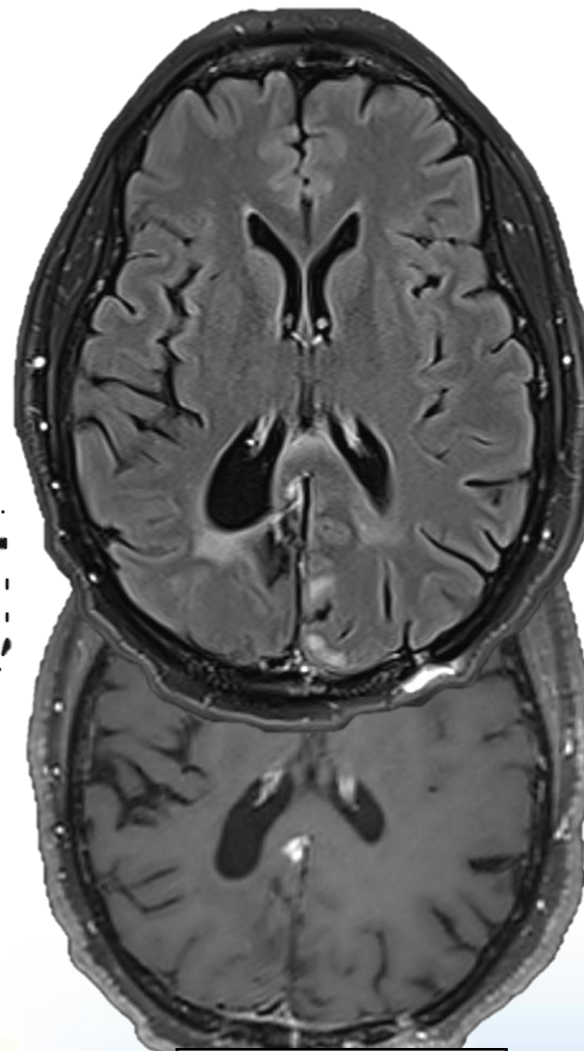


25 Enero 2021

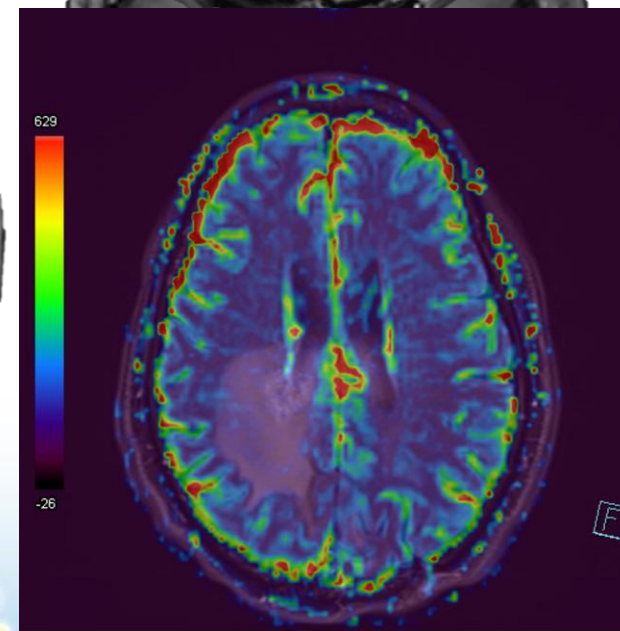
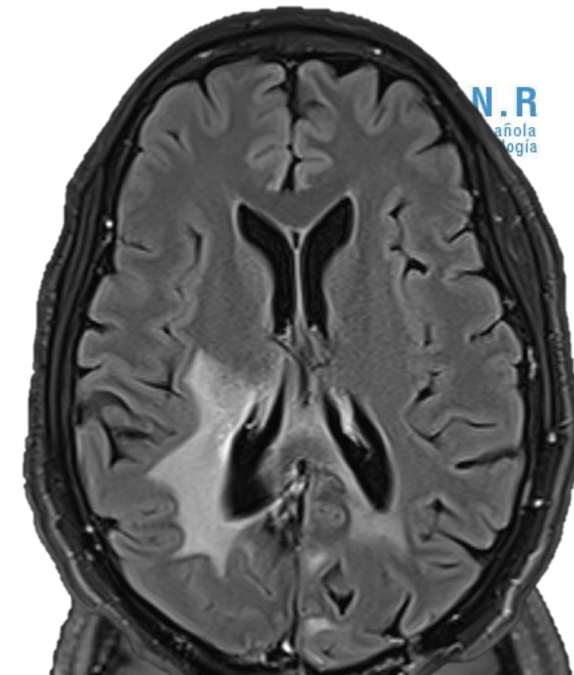


RM intraop
26 Enero 2021

2 Marzo 2021



22 junio 2022



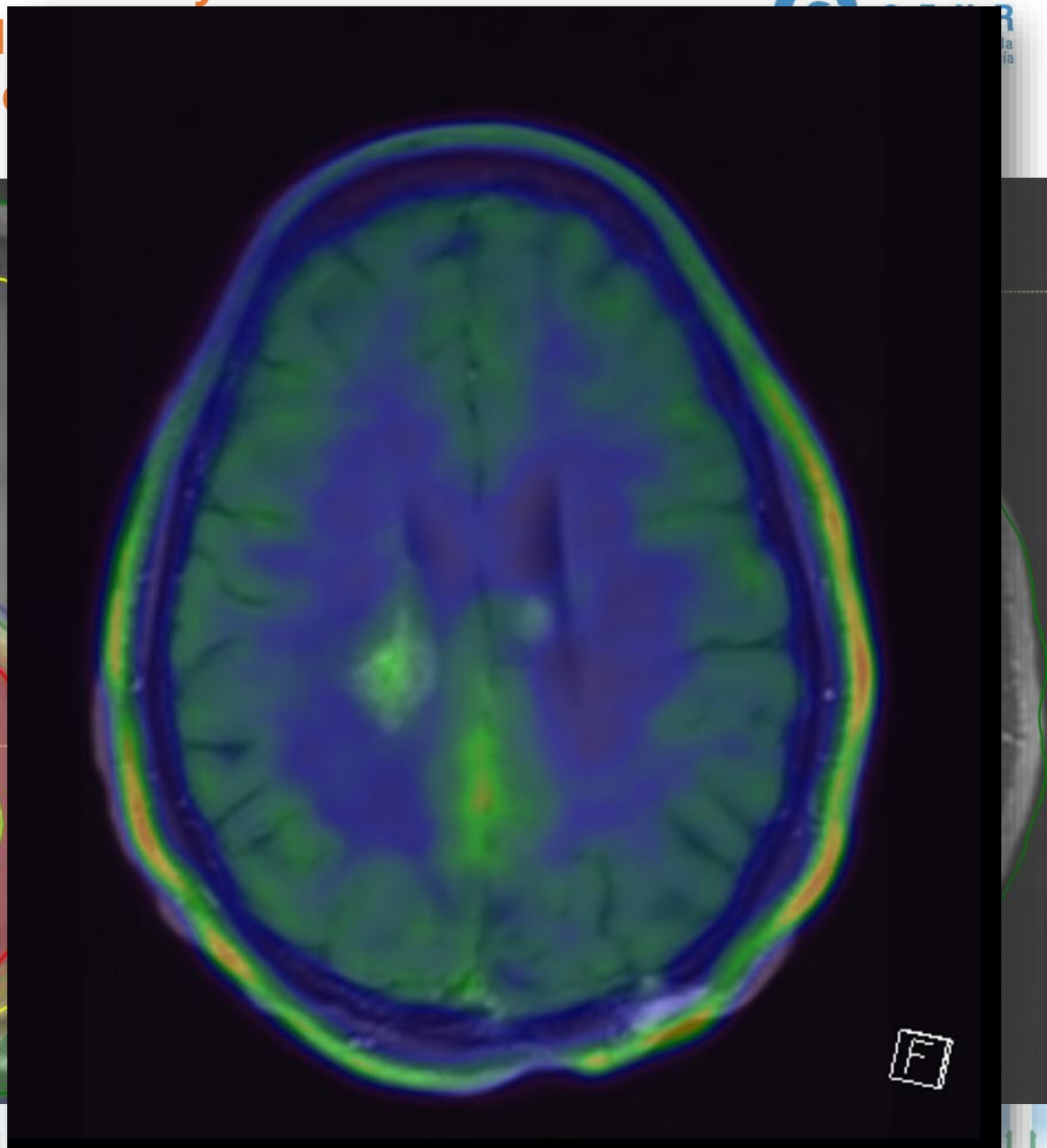
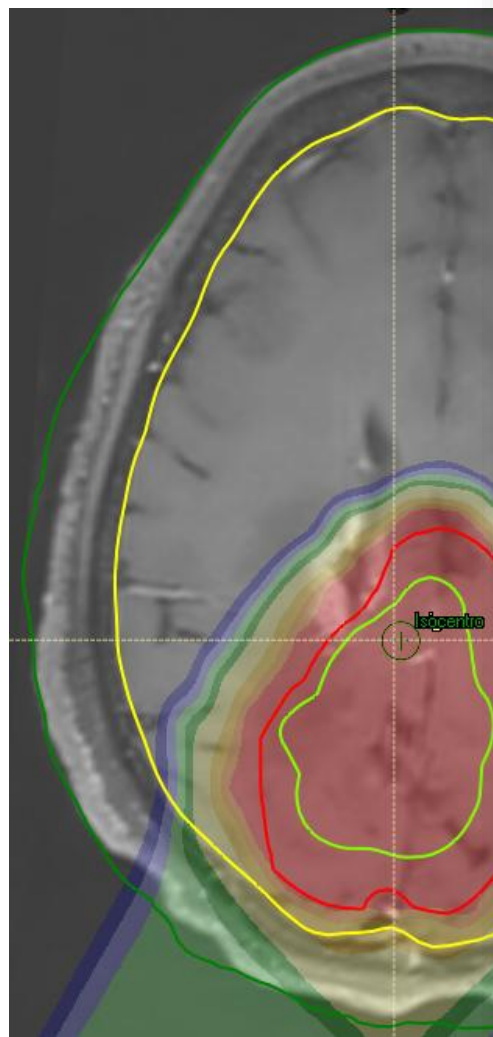
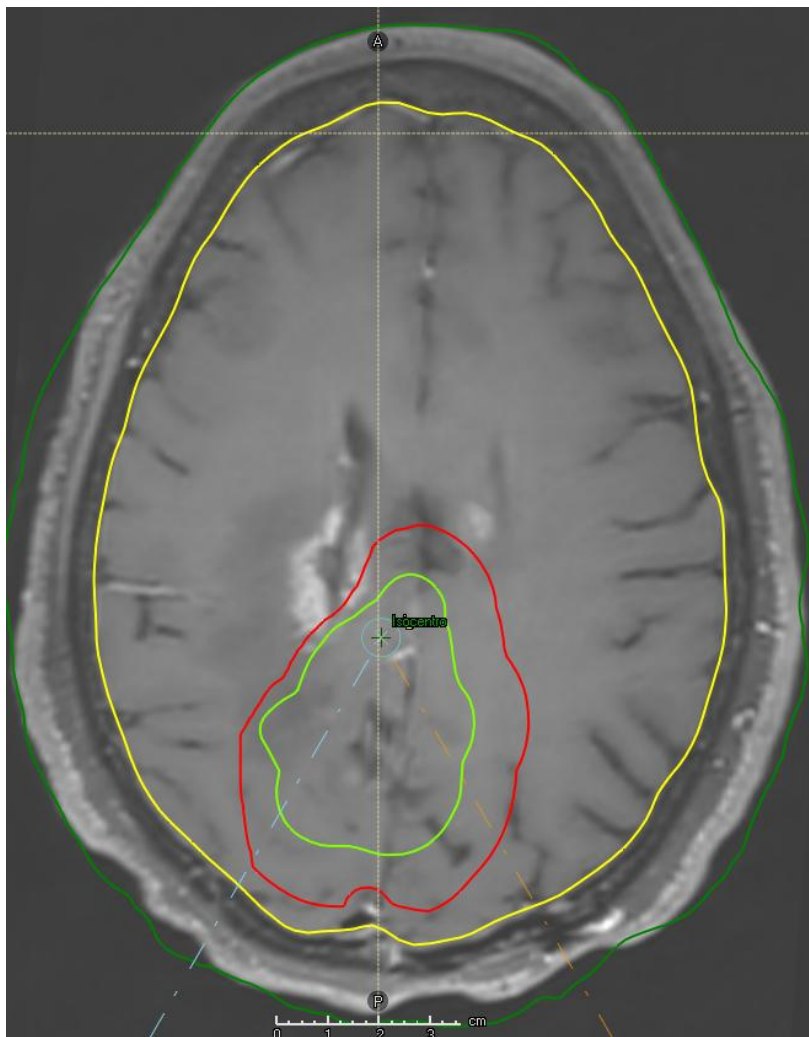
22 sep 2022

8 Abril 2021



60-65Gy/20

¿Recidiva?
Picos de Bragg



Cortesía Dr. Aristu, Unidad Protónterapia, CUN Madrid

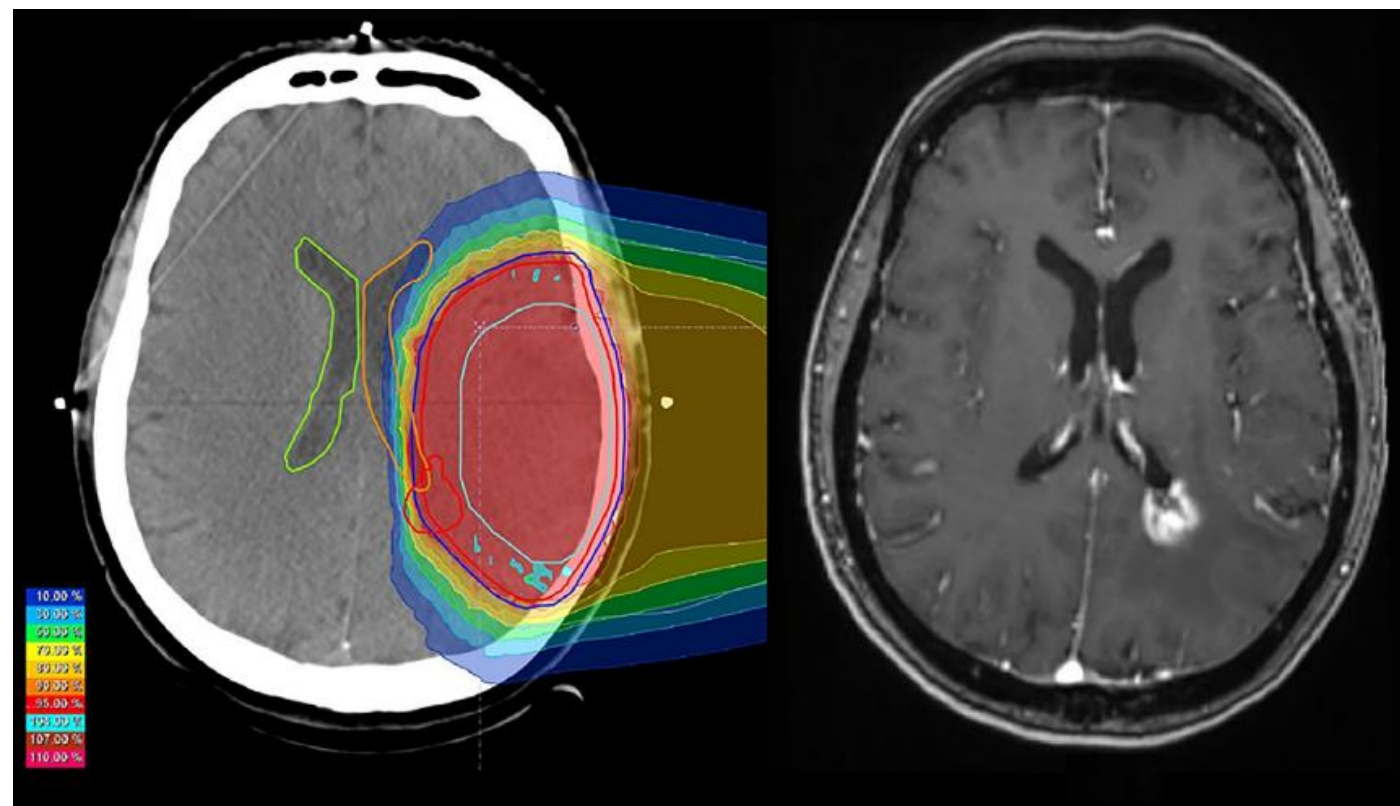
Original Article

Radiation induced contrast enhancement after proton beam therapy in patients with low grade glioma – How safe are protons?



Semi B. Harrabi^{a,b,c,d,e,*}, Bastian von Nettelbladt^{a,c,d}, Clemens Gudden^a, Sebastian Adeberg^{a,c,d}, Katharina Seidensaal^{a,c,d}, Julia Bauer^{b,c,d}, Emanuel Bahn^{a,c,d,e}, Andrea Mairani^{b,g}, Markus Alber^{a,c,d}, Thomas Haberer^b, Juergen Debus^{a,b,c,d,e,f}, Klaus Herfarth^{a,b,c,d}

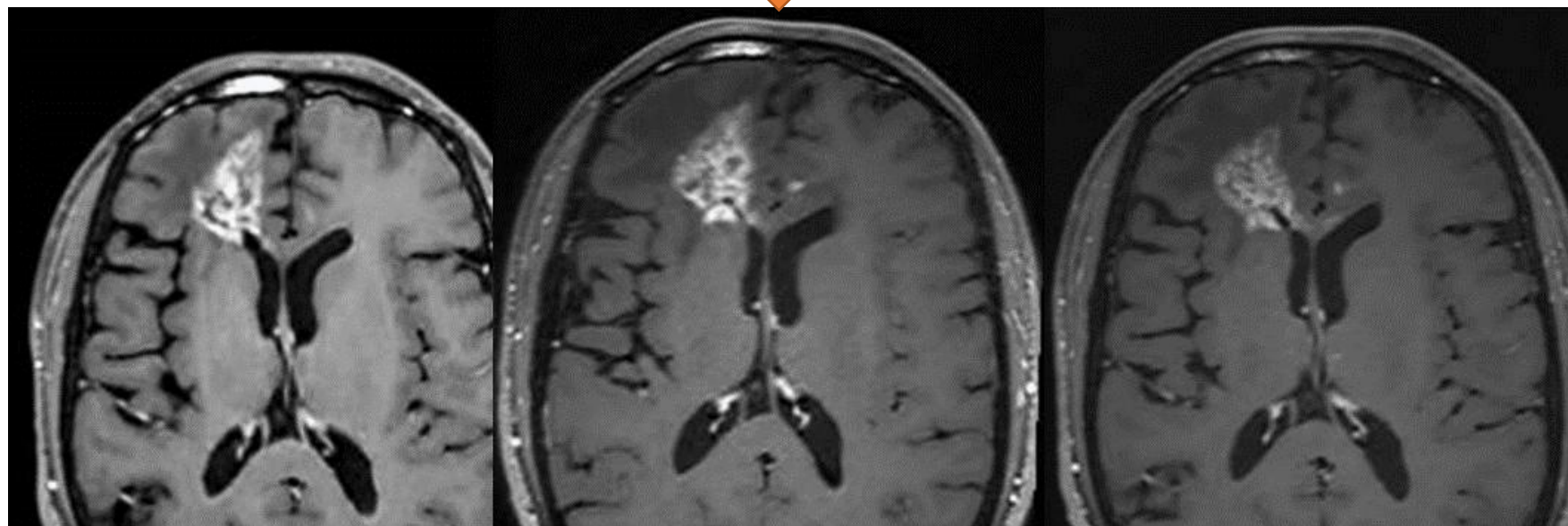
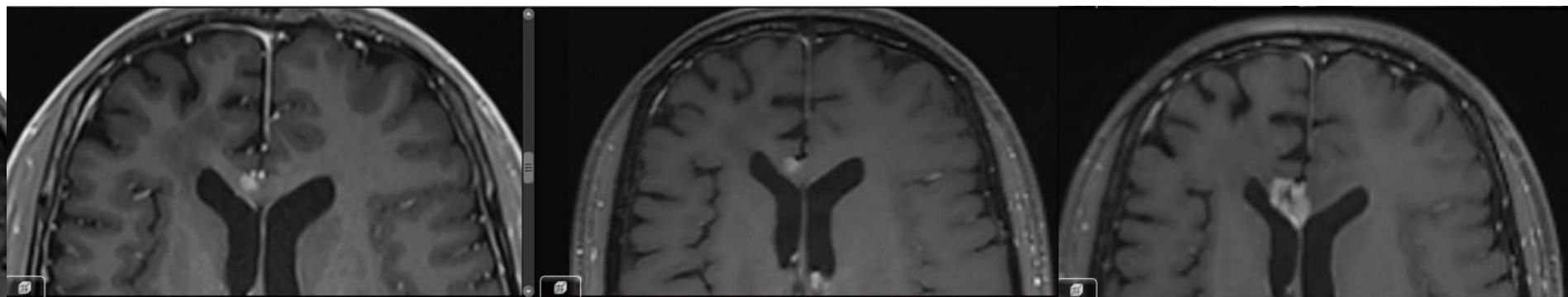
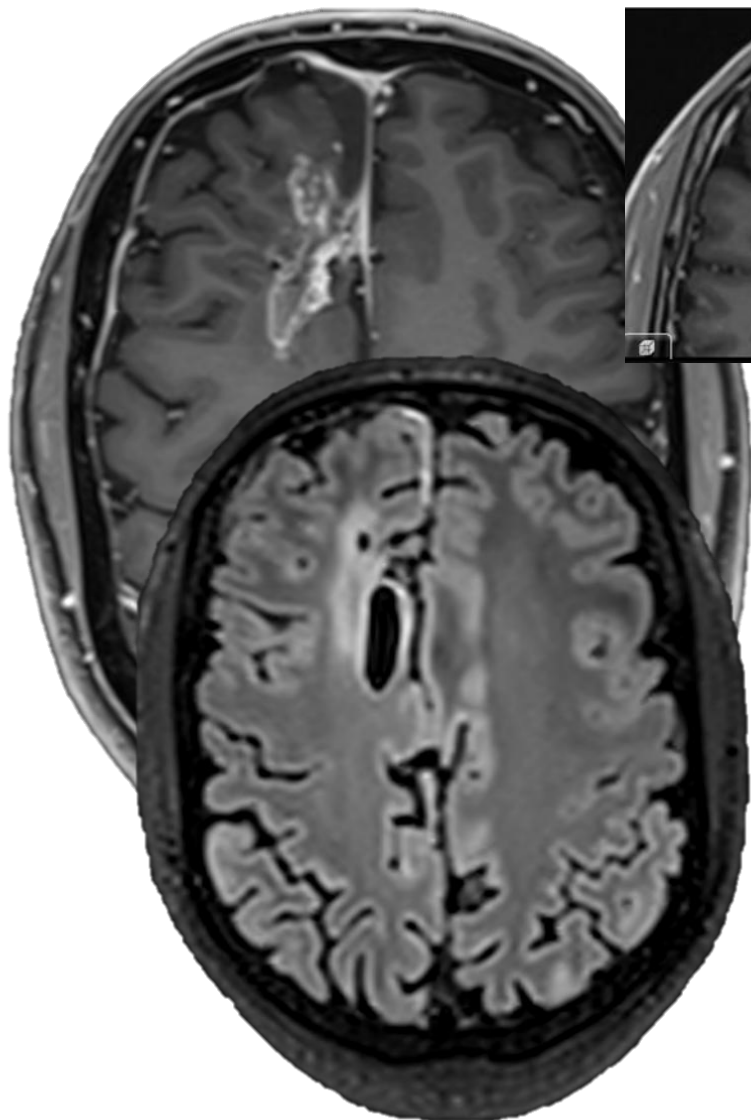
- RICE
- Incidencia alta, pero asintomática
- Radionecrosis sintomática, similar a fotones



typical periventricular RICE is depicted on a T1-weighted follow up MRI 15 months after PRT. The corresponding treatment plan an



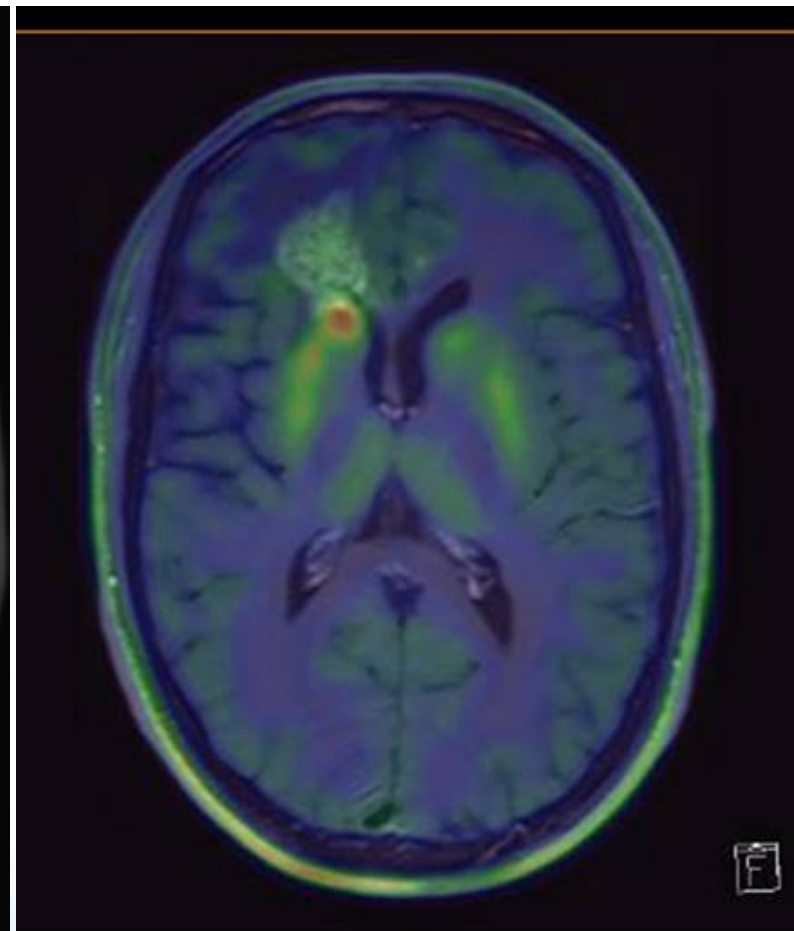
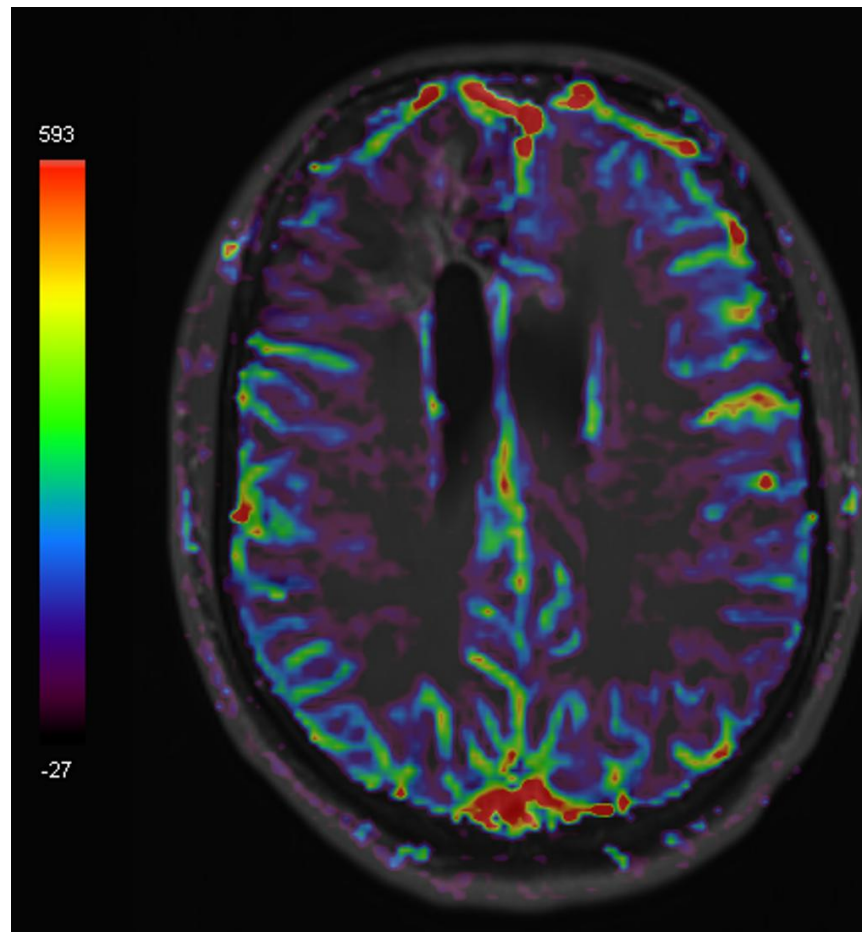
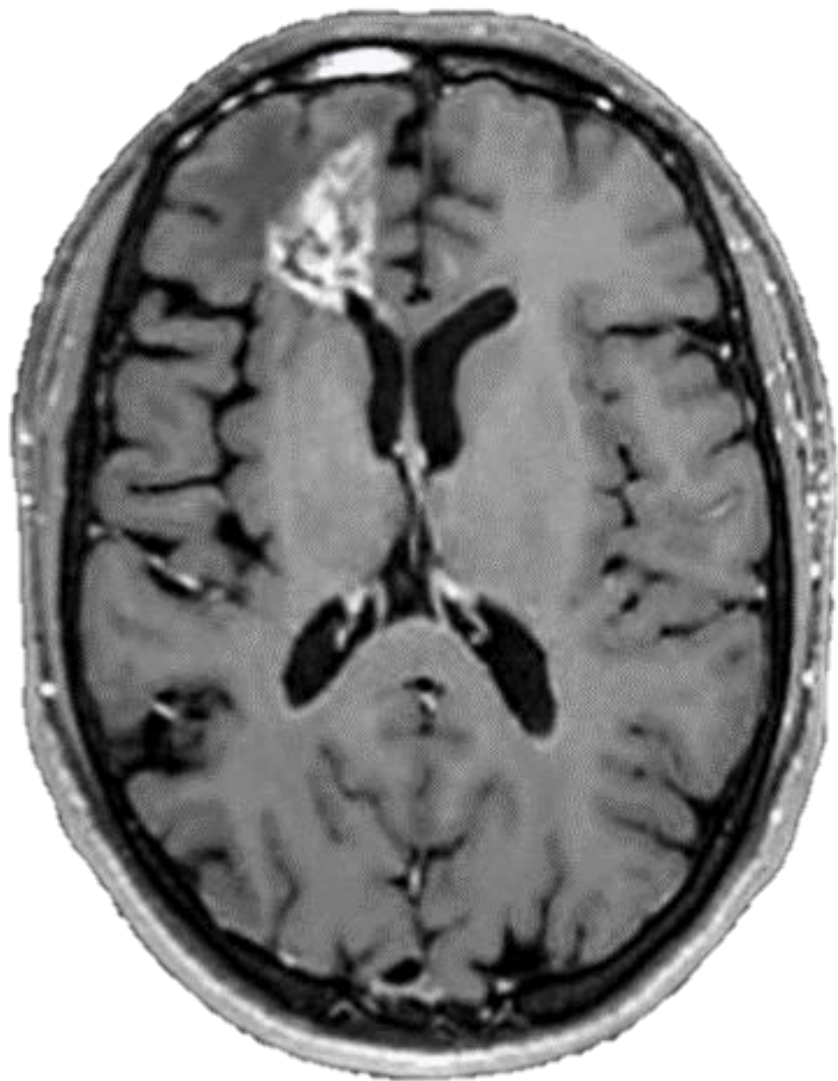
Astro BG → Astro 3



2020 PT 60Gy 25 fracciones + TMZ



Astro BG → Astro 3

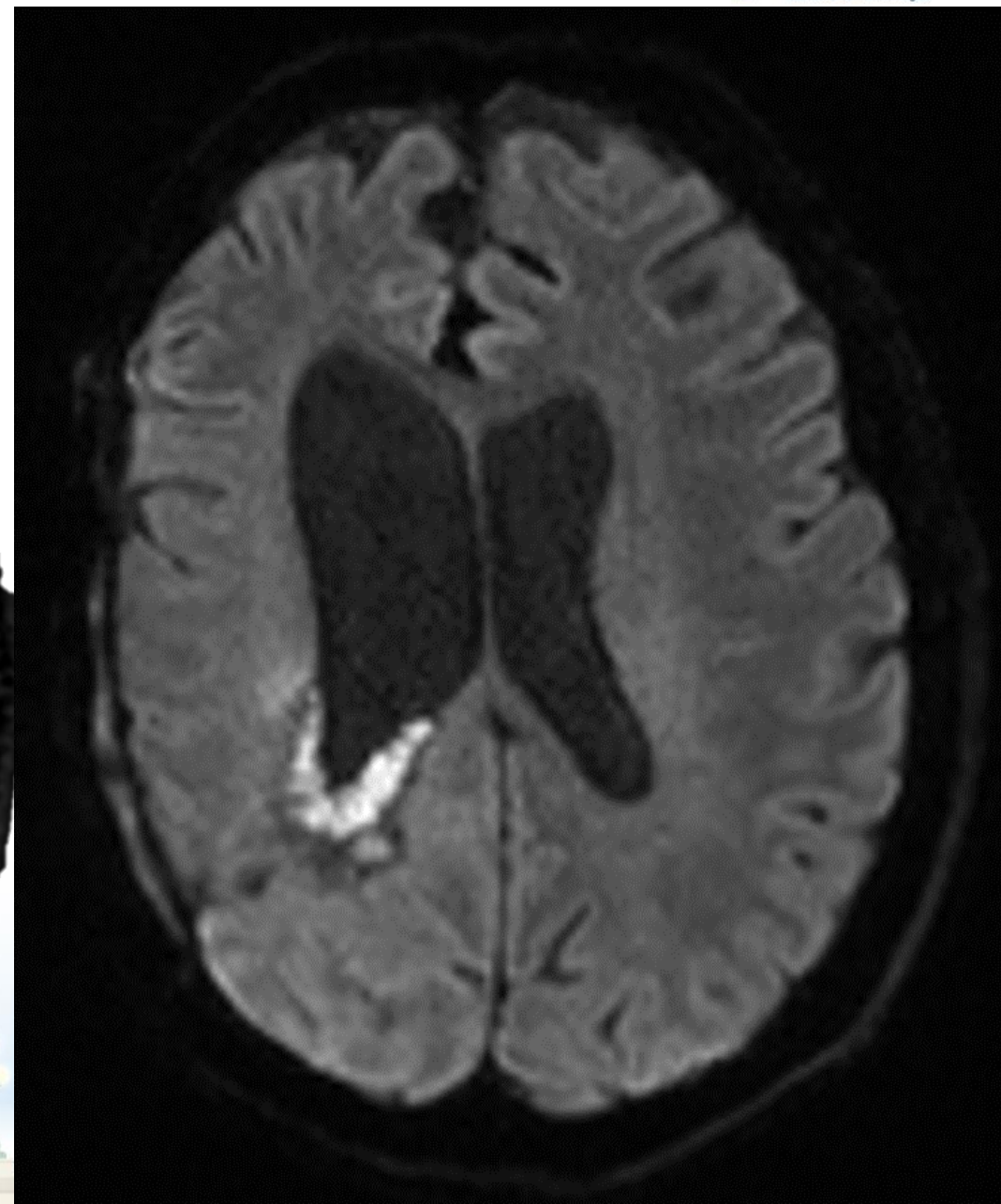
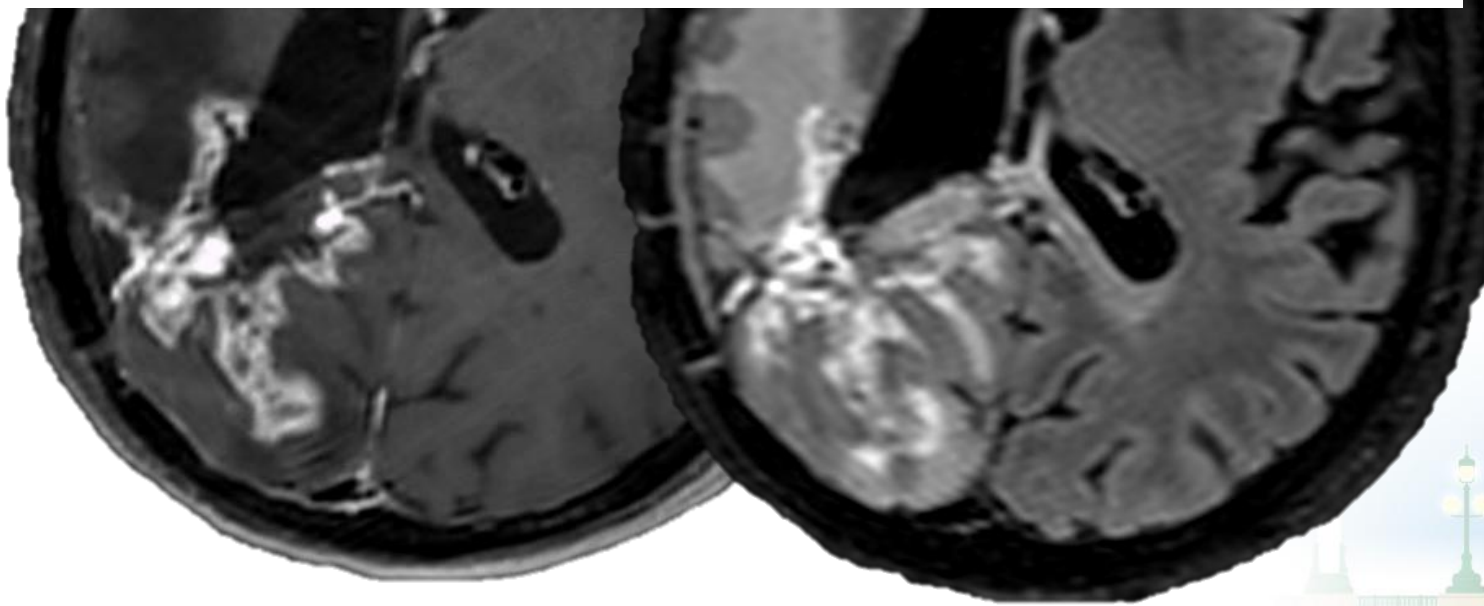




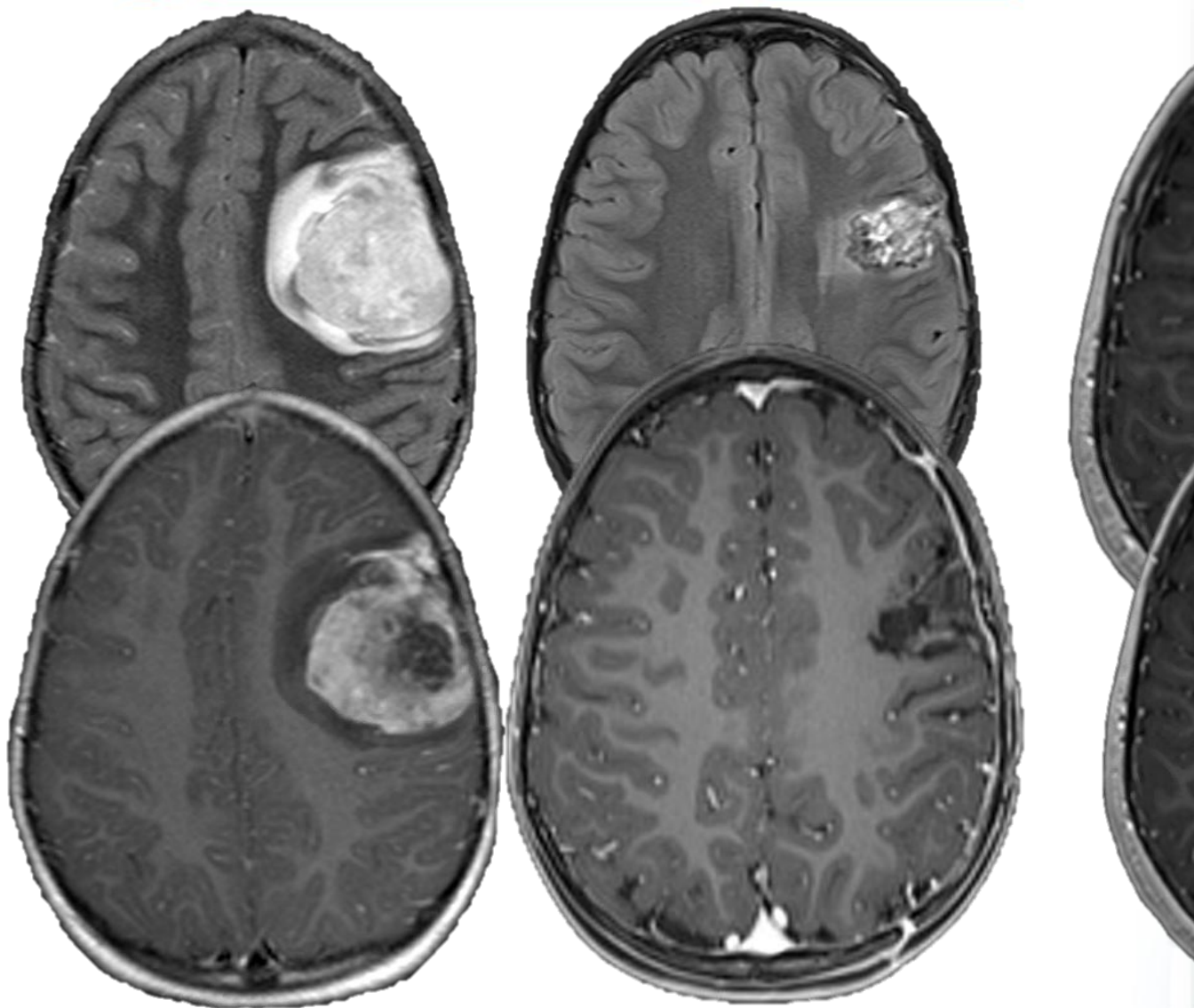
ORIGINAL RESEARCH
ADULT BRAIN

Progressing Bevacizumab-Induced Diffusion Restriction Is Associated with Coagulative Necrosis Surrounded by Viable Tumor and Decreased Overall Survival in Patients with Recurrent Glioblastoma

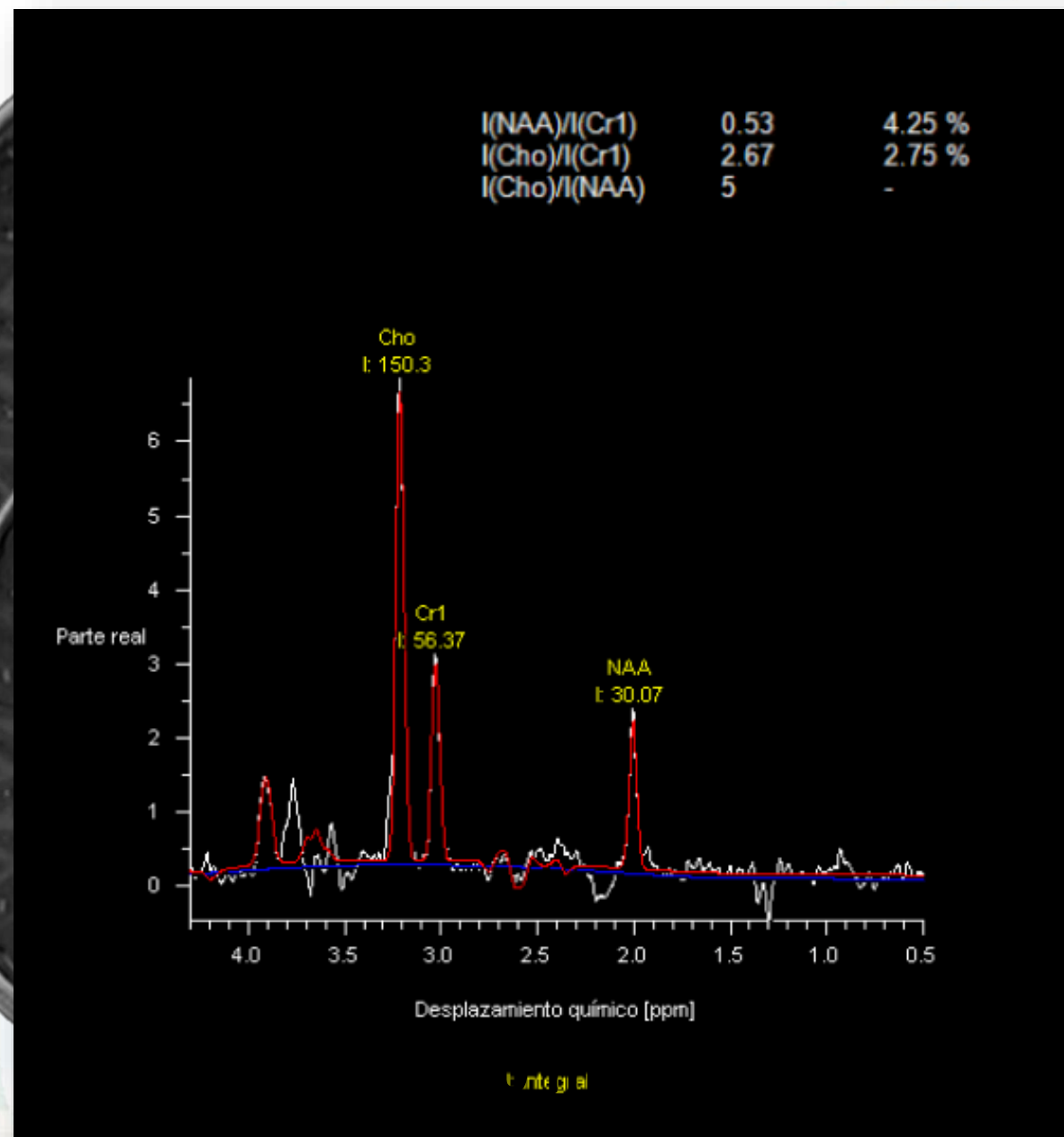
 H.S. Nguyen,  N. Milbach,  S.L. Hurrell,  E. Cochran,  J. Connelly,  J.A. Bovi,  C.J. Schultz,  W.M. Mueller,  S.D. Rand,  K.M. Schmainda, and  P.S. LaViolette



Sarcoma cerebral primario



+ 4 meses



Skull Base Chordoma and Chondrosarcoma:

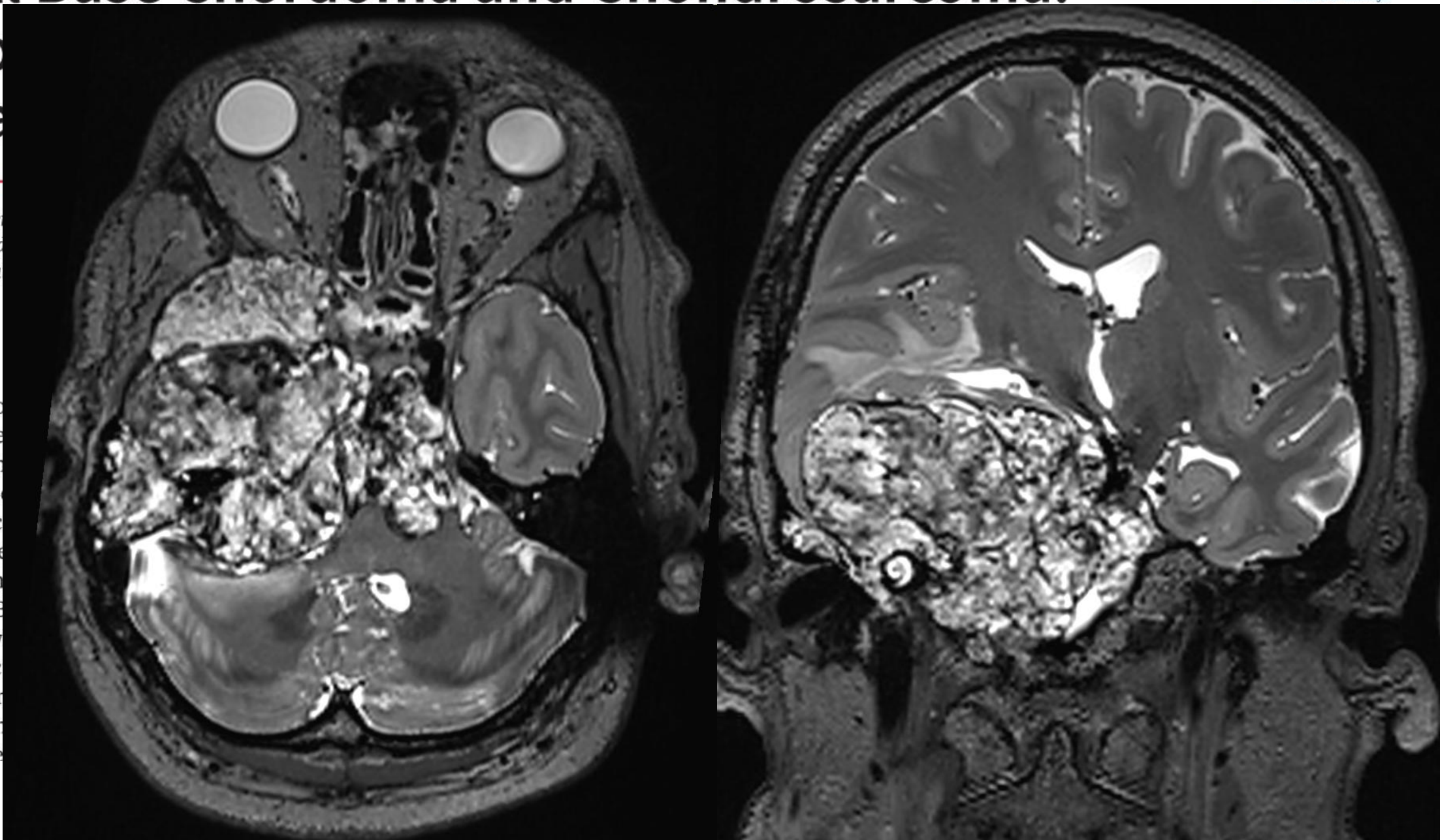
Neuro Ma

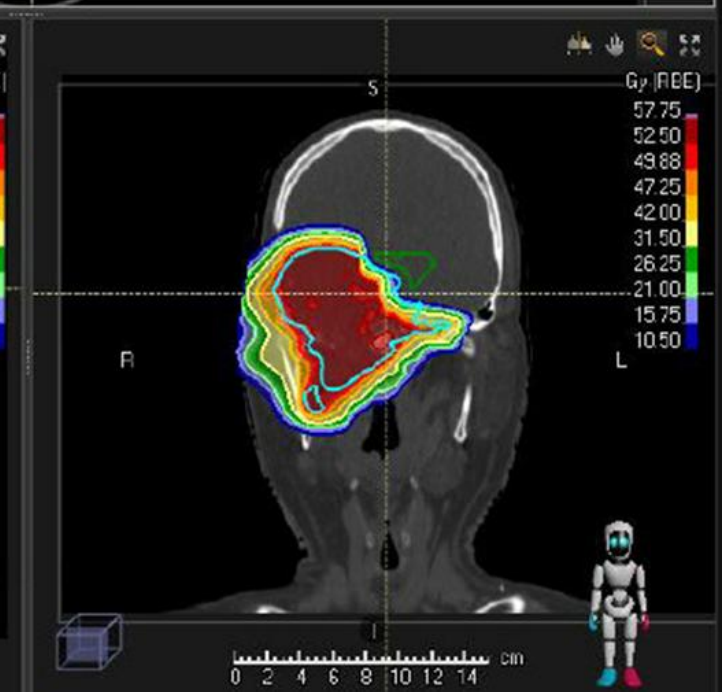
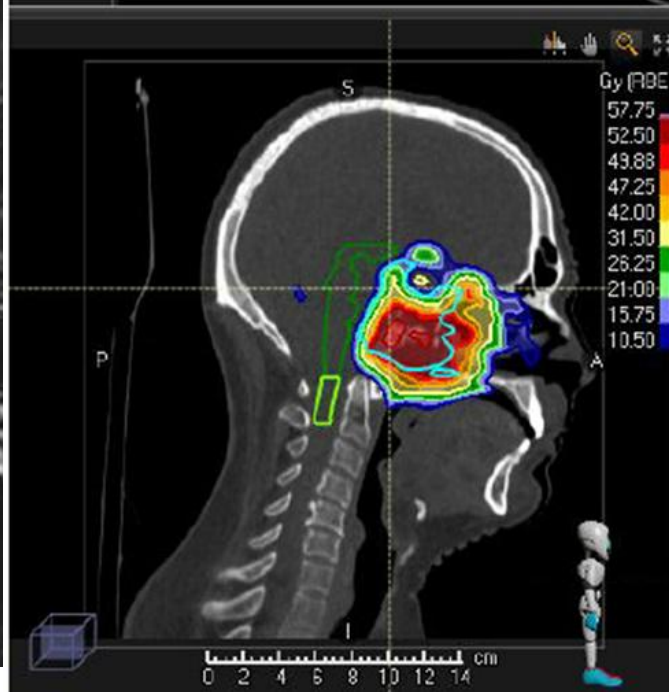
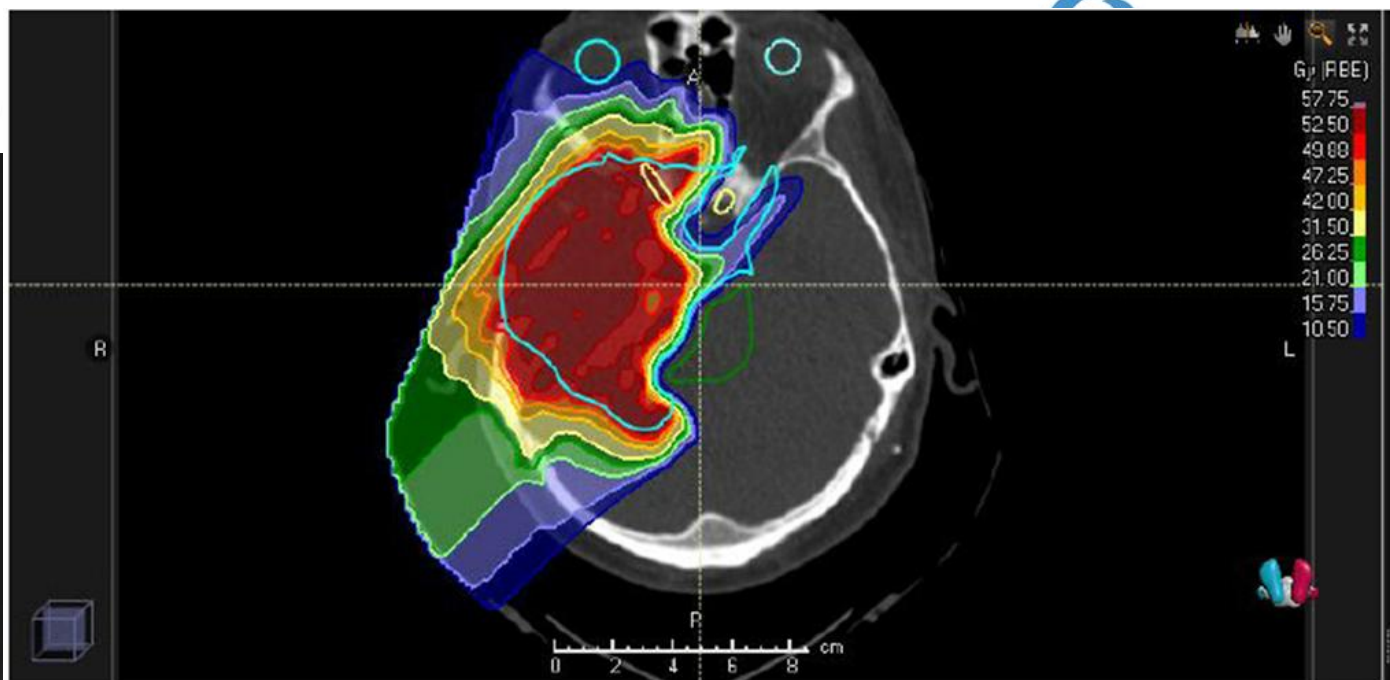
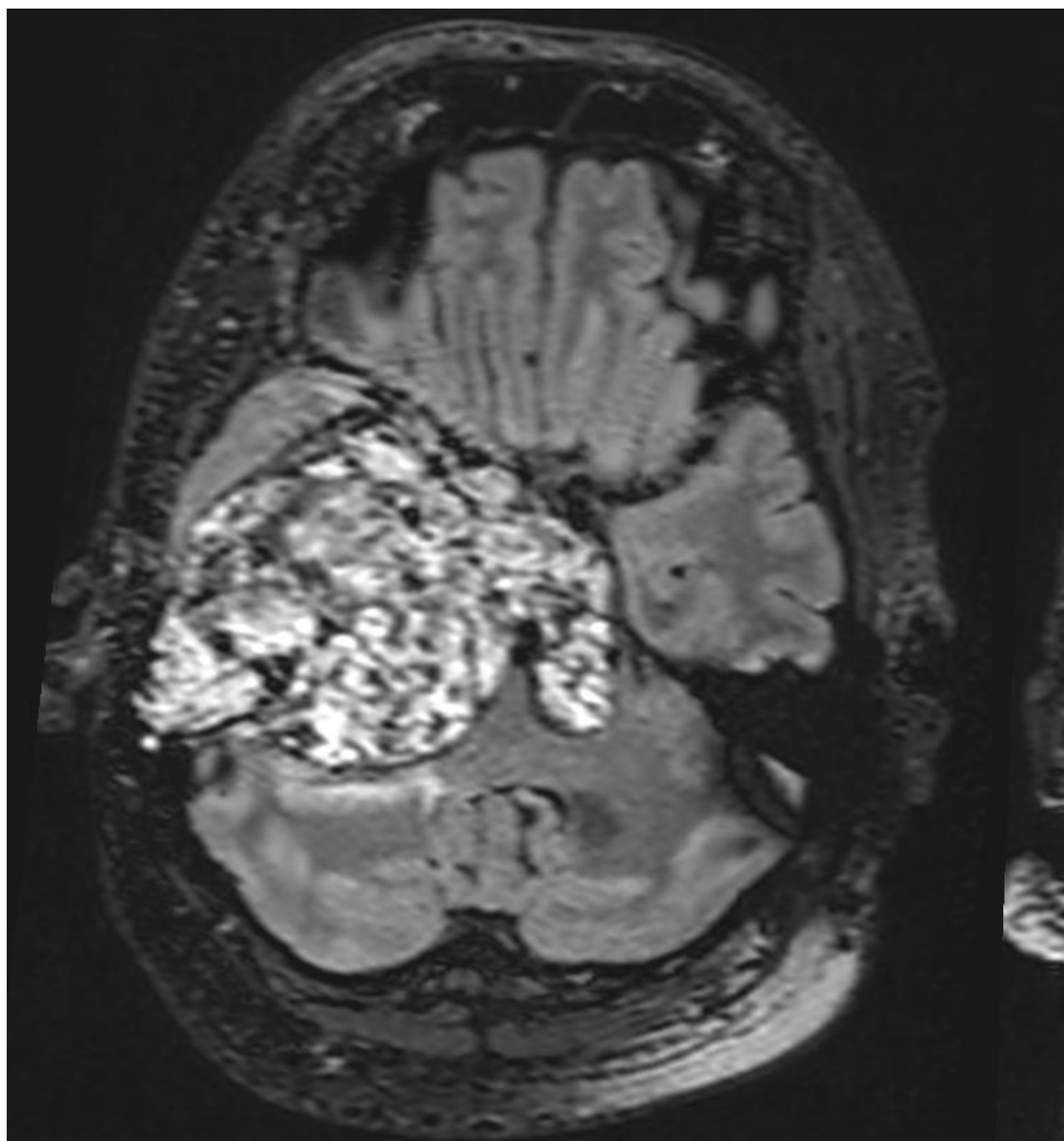
Gillian M. Potter

Philip Broad

Charlotte L. Ha

Skull base chordoma is a rare, locally aggressive tumor. Examples of imaging in safe surgical resection, expanded endoscopic layer skull base resection, and frequently administered beam therapy (PBT) dose escalation with structures, particularly energy deposition decrease at the end (non). Essential re





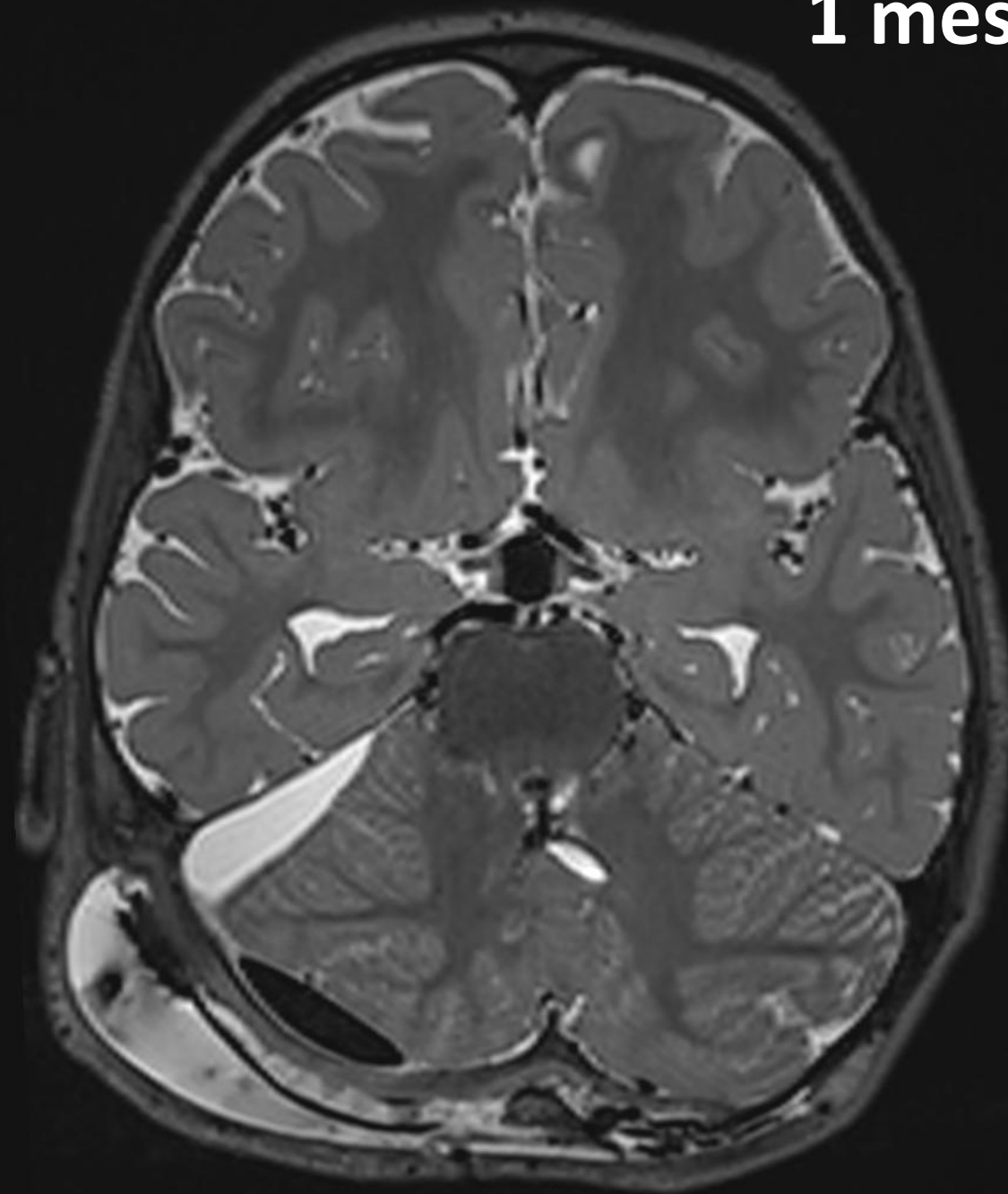
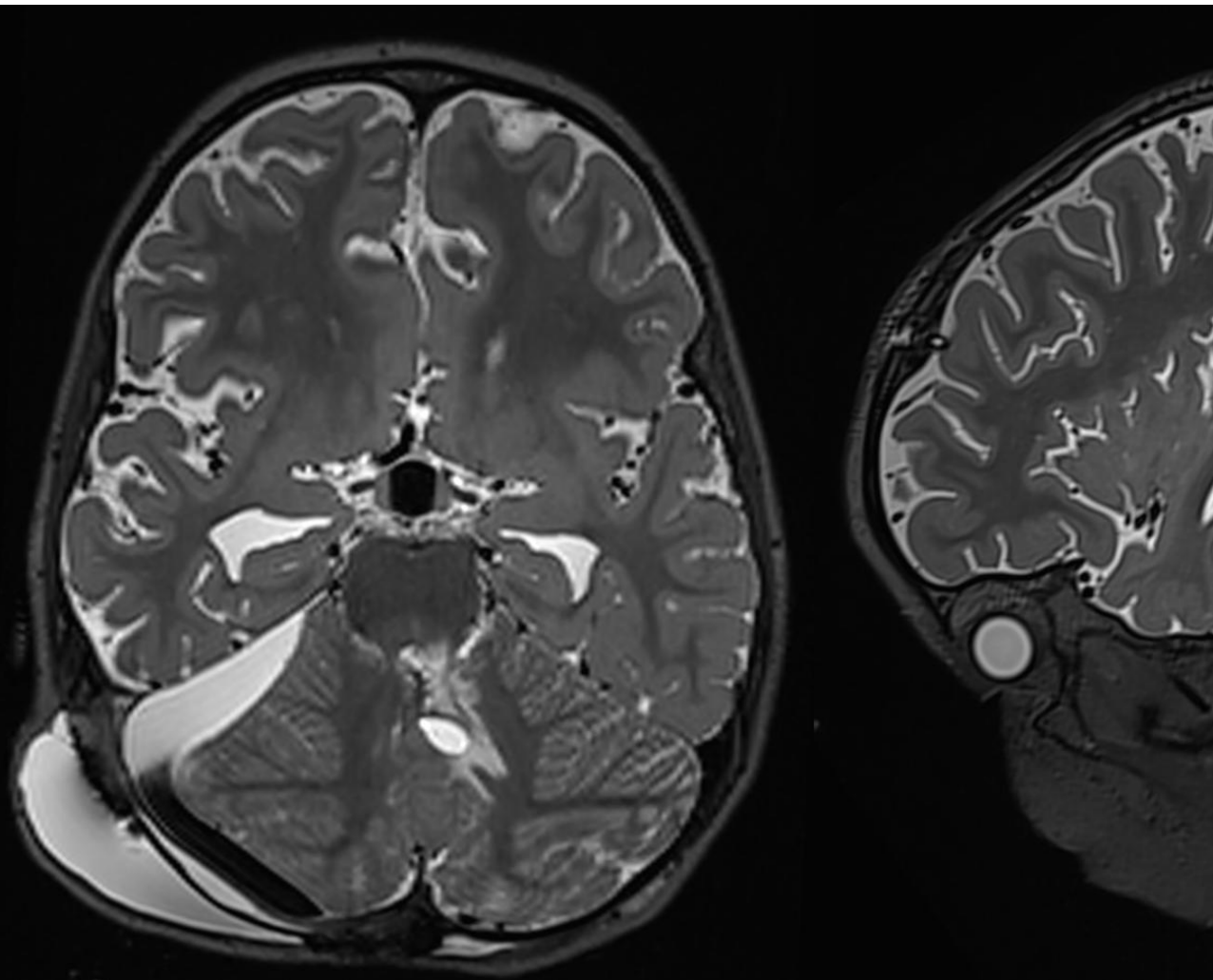


Reunión Anual
SOCIEDAD ESPAÑOLA DE
NEURORRADIOLOGÍA

SAN SEBASTIÁN

7 - 9 de noviembre de 2024

1 mes





CONCLUSIONES / CONCEPTOS CLAVE

- Indicaciones de Protonterapia
- Picos Bragg
- Planificación / Secuencias 3D
- Complicaciones (RICE)
- Base cráneo / Pediátricos





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