IMAGING IN BRAIN TUMORS – SPECIAL FOCUS ON CNS ORGAN CONTOURING

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33rd AROI-ICRO SUN Teaching Course on Paediatric Malignancies
12th – 13th October, 2019
RMLIMS, Lucknow, Uttar Pradesh

- Focus on OARs in RT
- Not a contouring tutorial/workshop/FALCON!
- Strongly recommend to pursue the ref./orig. articles!!!

- Organ At Risk as a concept/conceptual entity
- Relative
- Level I/'Critical' OAR: E.g. – Brain stem; Spinal Cord

International Journal of
Radiation Oncology
biology ● physics

www.redjournal.org

Physics Contribution

Standardizing Naming Conventions in Radiation Oncology

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0360-3016/$ - see front matter
doi:10.1016/j.ijrobp.2011.09.054

Table 1 Examples of target volume (TV) names

TV ICRU name	Primary/ node	Single/ multiple	Number	Prescription dose (cGy)	Proposed name
PTV	Primary	Single	N/A	5000	PTV_5000
PTV	Node	Multiple	1	5000	PTVn1_5000
CTV	Node	Multiple	2	4000	CTVn2_4000
PTV	Node	Multiple	2	4000	PTVn2_4000
PTV	Primary	Multiple	1	5000	PTVp1_5000

Table 2 Planning organs at risk volumes

Organ at risk name	Left/right	Margin (mm)	Proposed name
SpinalCord	N/A	Nonuniform	SpinalCord_PRV
SpinalCord PRV	N/A	5	SpinalCord _05
Parotid	Left	0	Parotid_L
Parotid	Right	0	Parotid_R
Total parotid	Left+Right	0	Parotids
Kidney	Left	10	Kidney_L_10

Table 3a Standardized organ at risk names

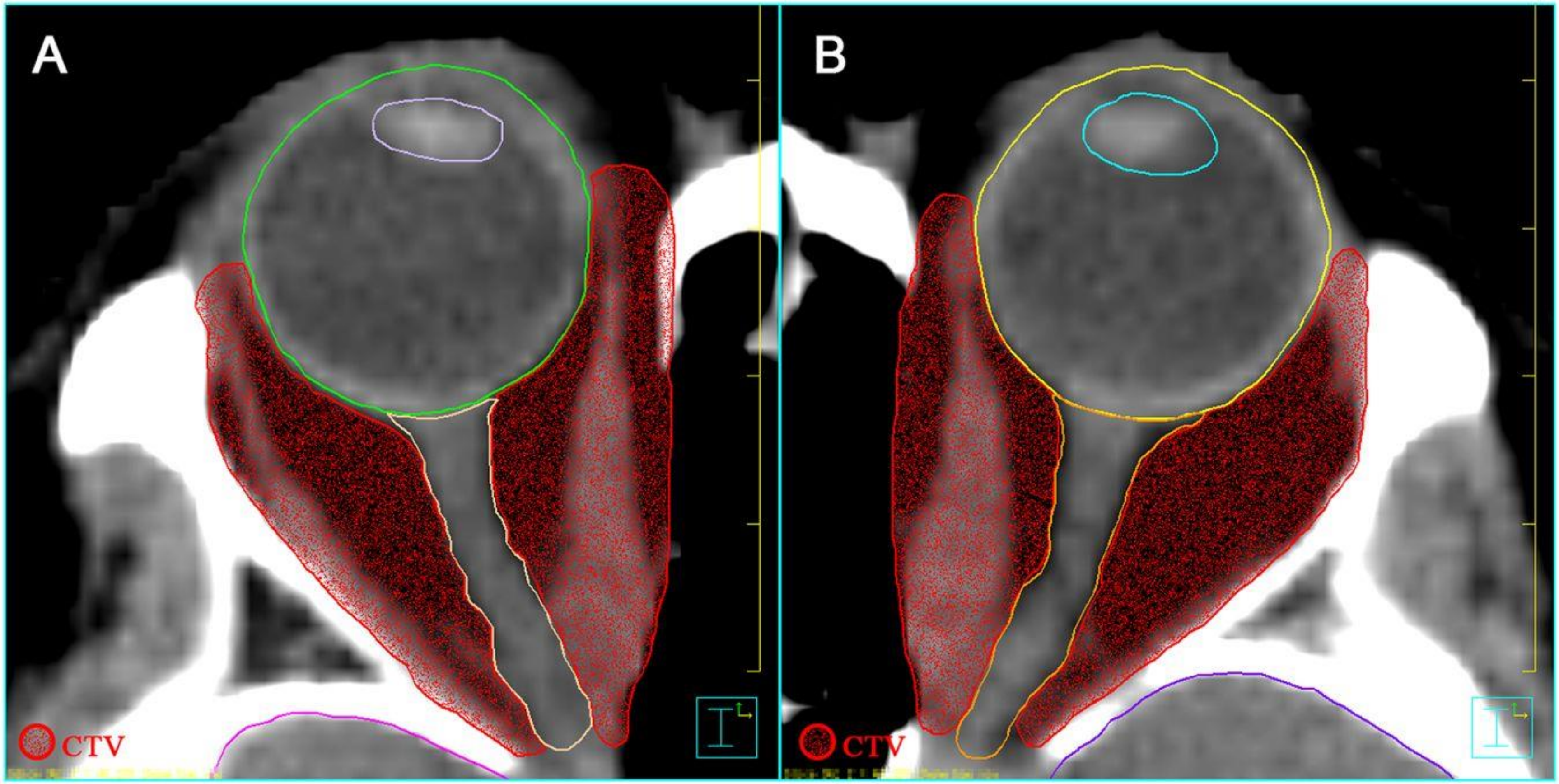
Standard names	Description	Standard names	Description
AnalCanal	Anal Canal	**Esophagus_Middle**	**Middle Esophagus**
A_Pulmonary	**Pulmonary Artery**	External	Skin
A_Carotid	**Carotid Artery**	**Eye**	**Eye**
A_Brachiocephali	**Brachiocephalic Artery**	Femur	Femur
A_Coronary	**Coronary Artery**	**FemoralJoint**	**Femoral Joint**
A_Subclavicular	**Subclavicular Artery**	**FrontalLobe**	**Frontal Lobe**
A_Hypophyseal	**Hypophyseal Artery**	**GHJoint**	**Glenohumeral Joint**
Aorta	**Aorta**	Globe	Eye Globe
AnalSphincter	**Anal Sphincter**	Glottis	Glottis
Atrium	**Atrium**	GreatVessel	Great Vessel
Bladder	Bladder	Heart	Heart
BladderWall	**Bladder Wall**	**Hippocampus**	**Hippocampus**
BrachialPlexus	Brachial Plexus	**Hypothalamus**	**Hypothalamus**
Brain	Brain	Kidney	Kidney
BrainStem	Brain Stem	LargeBowel	Large Bowel
Breast	Breast	Larynx	Larynx
BronchialTree	Bronchial Tree	LacrimalGland	Lacrimal Gland
BaseOfTongue	**Base of Tongue**	Lens	Eye Lens
Carina	Carina	Lips	Lips
CaudaEquina	Cauda Equina	Liver	Liver
Cerebellum	Cerebellum	Lung	Lung
Cerebrum	Cerebrum	Mandible	Mandible
Chiasm	Optic Chiasm	**MassMuscle**	**Masseter Muscle**
CN_VII	Seventh Cranial Nerve	**Mediastinum**	**Mediastinum**
CN_VIII	Eighth Cranial Nerve	MainBronchus	Main Bronchus
Cervix	**Cervix**	**OccipitalLobe**	**Occipital Lobe**
Cochlea	Cochlea	OpticNerve	Optic Nerve
Colon	**Colon**	OralCavity	Oral Cavity
ConstrMuscle	**Constrictor Muscle**	Ovary	Ovary
Cornea	Cornea	**Parametrium**	**Parametrium**
Duodenum	Duodenum	**ParietalLobe**	**Parietal Lobe**
Ear_Middle	Middle Ear	**Pancreas**	**Pancreas**
Ear_External	External Ear	Parotid	Parotid
Esophagus	Esophagus	**PelvicBones**	**Pelvic Bones**
Esophagus_Upper	**Upper Esophagus**	PenileBulb	Penile Bulb
Esophagus_Lower	**Lower Esophagus**	**Penis**	**Penis**

Table 3b Standardized organ at risk names

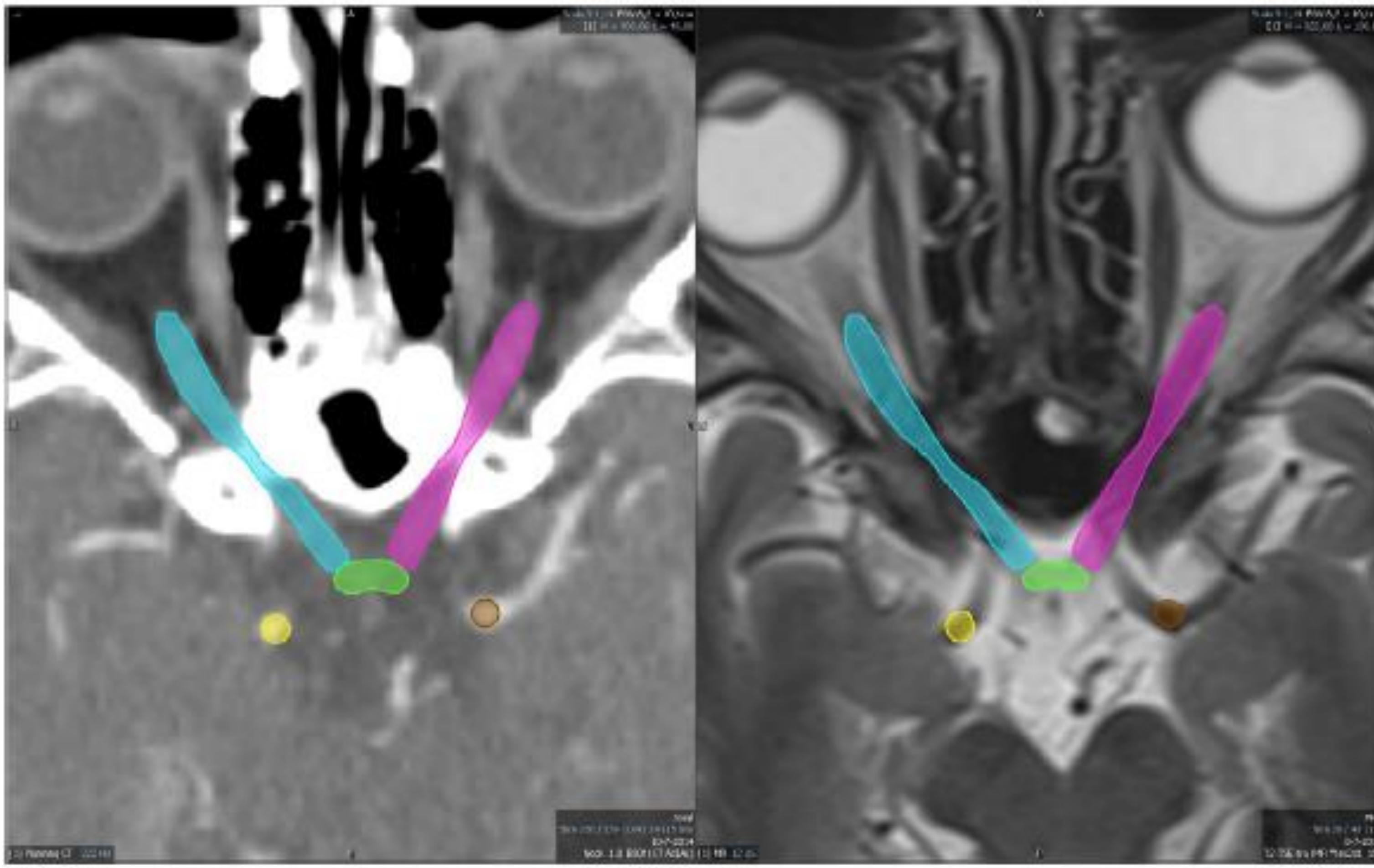
Standard names	Description
Perineum	Perineum
Pericardium	**Pericardium**
Pharynx	Pharynx
PharynxConst	**Pharyngeal Constrictor**
Pituitary	Pituitary
Prostate	Prostate
PubicSymphysis	**Pubic Symphysis**
Rectum	Rectum
RectalWall	**Rectal Wall**
Retina	Retina
Rib	Rib
Sacrum	Sacrum
SalivaryGland	**Salivary Glands**
SeminalVesicle	Seminal Vesicle
SmallBowel	Small Bowel
SpinalCord	Spinal Cord
Spleen	**Spleen**
Stomach	Stomach
Submandibular	Submandibular Gland
Supertentorial	**Supertentorial**
TemporalLobe	Temporal Lobe
Testis	Testis
Thyroid	Thyroid
TMjoint	Temperomandibular Joint
Trachea	Trachea
Tongue	Tongue
Urethra	Urethra
Uterus	**Uterus**
V_Azygos	**Azygos Vein**
V_CavaInferior	**Inferior vena cava**
V_CavaSuperior	**Superior vena cava**
V_Pulmonary	**Pulmonary Vein**
V_SubClav	**SubClavicular Vein**
Vagina	**Vagina**
VB_Cervical	**Cervical Vertebrae**
VB_Thoracic	**Thoracic Vertebrae**
VB_Lumbar	**Lumbar Vertebrae**
VB_Sacrum	**Sacrum Vertebrae**
Ventricle	**Ventricle**
Vessels	Vessels
Vulva	Vulva

‘USUAL’ OARs

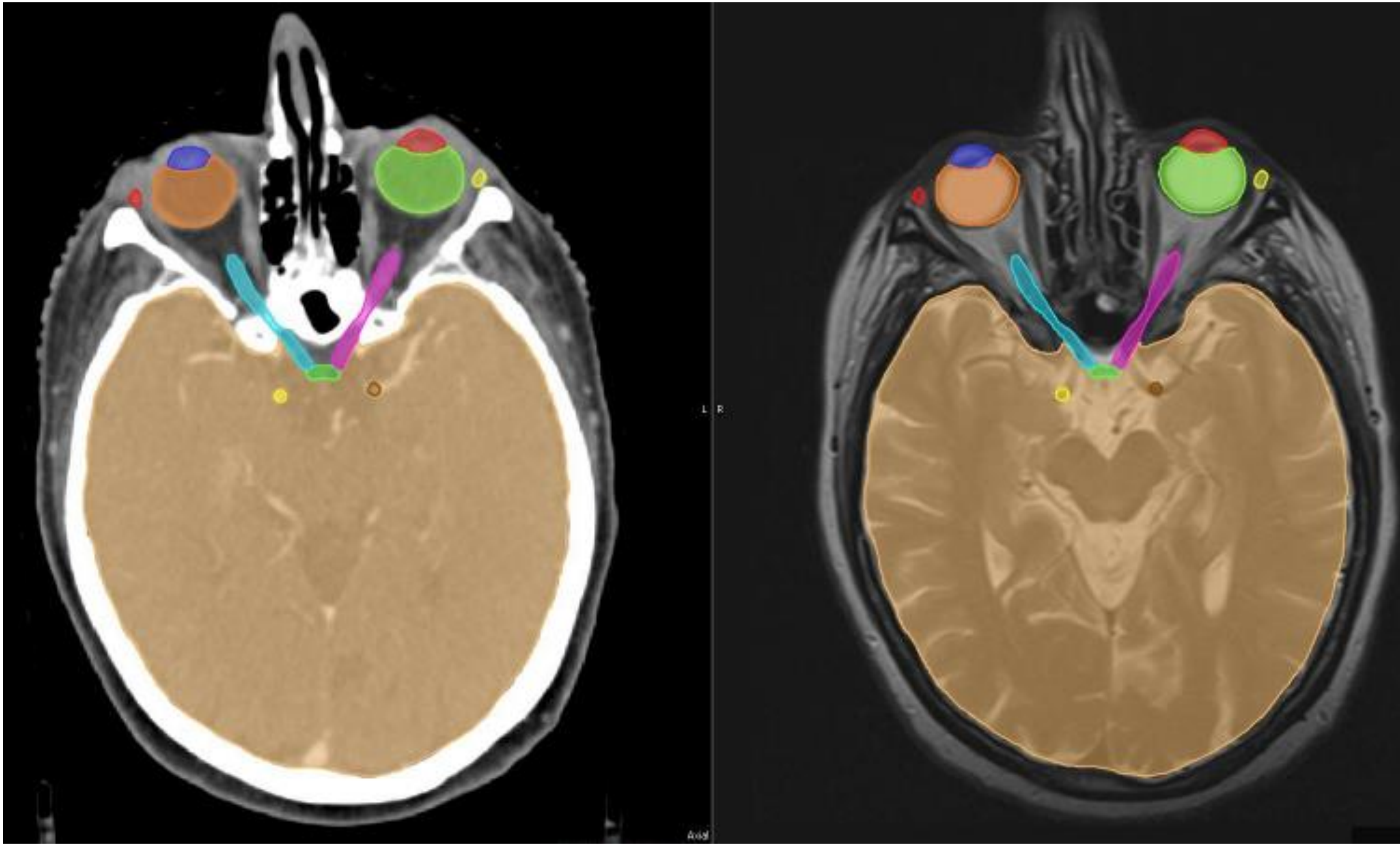
EYE & LENS



Optic nerves & Optic chiasm



2mm slice thickness


L R
Axial

‘OTHER’ OARs

MIDDLE EAR

Contouring the Middle and Inner Ear on Radiotherapy Planning Scans

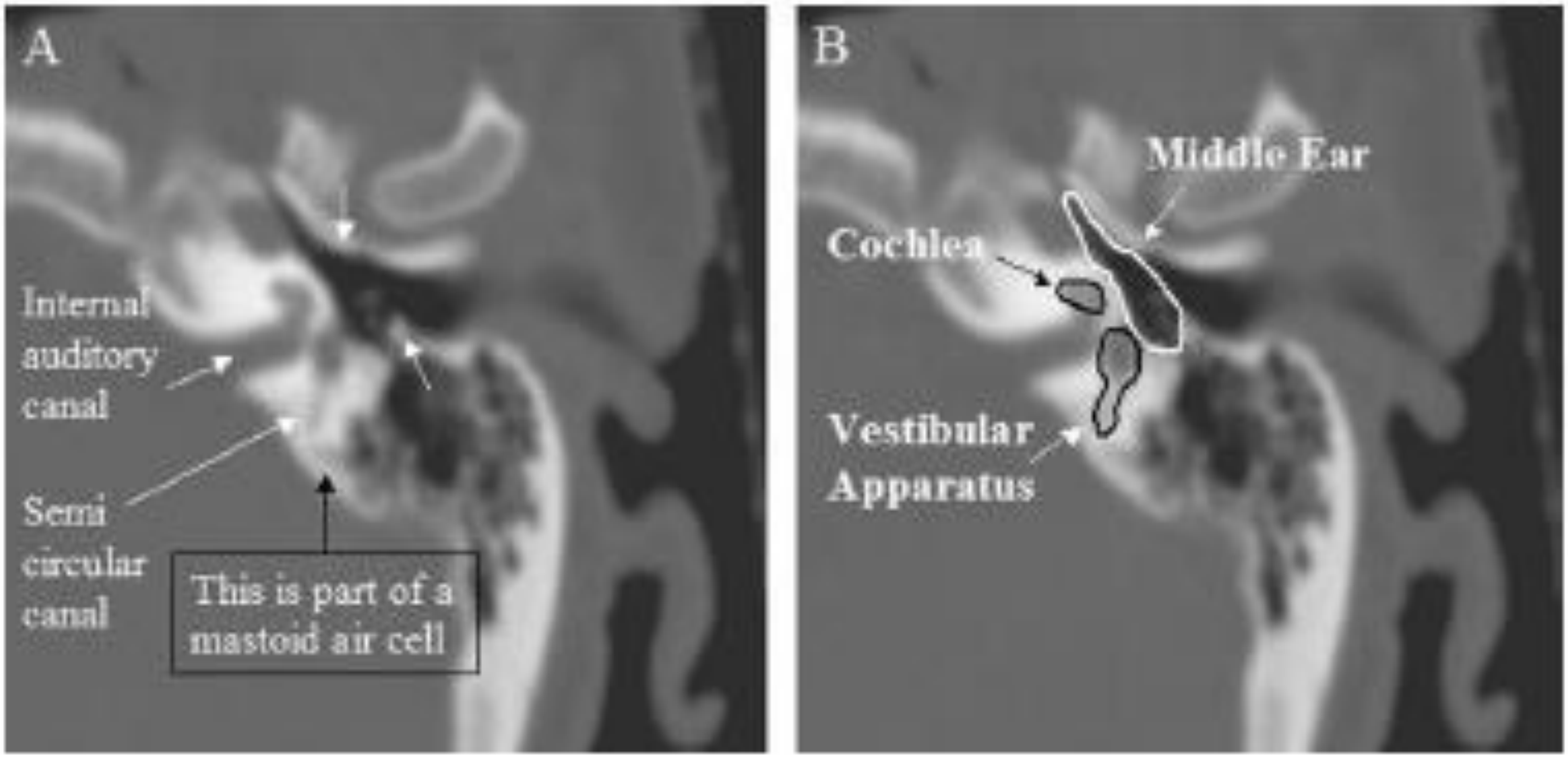
Heather D. Pacholke, MD, Robert J. Amdur, MD, Ilona M. Schmalfuss, MD, Debbie Louis, CMD, and William M. Mendenhall, MD

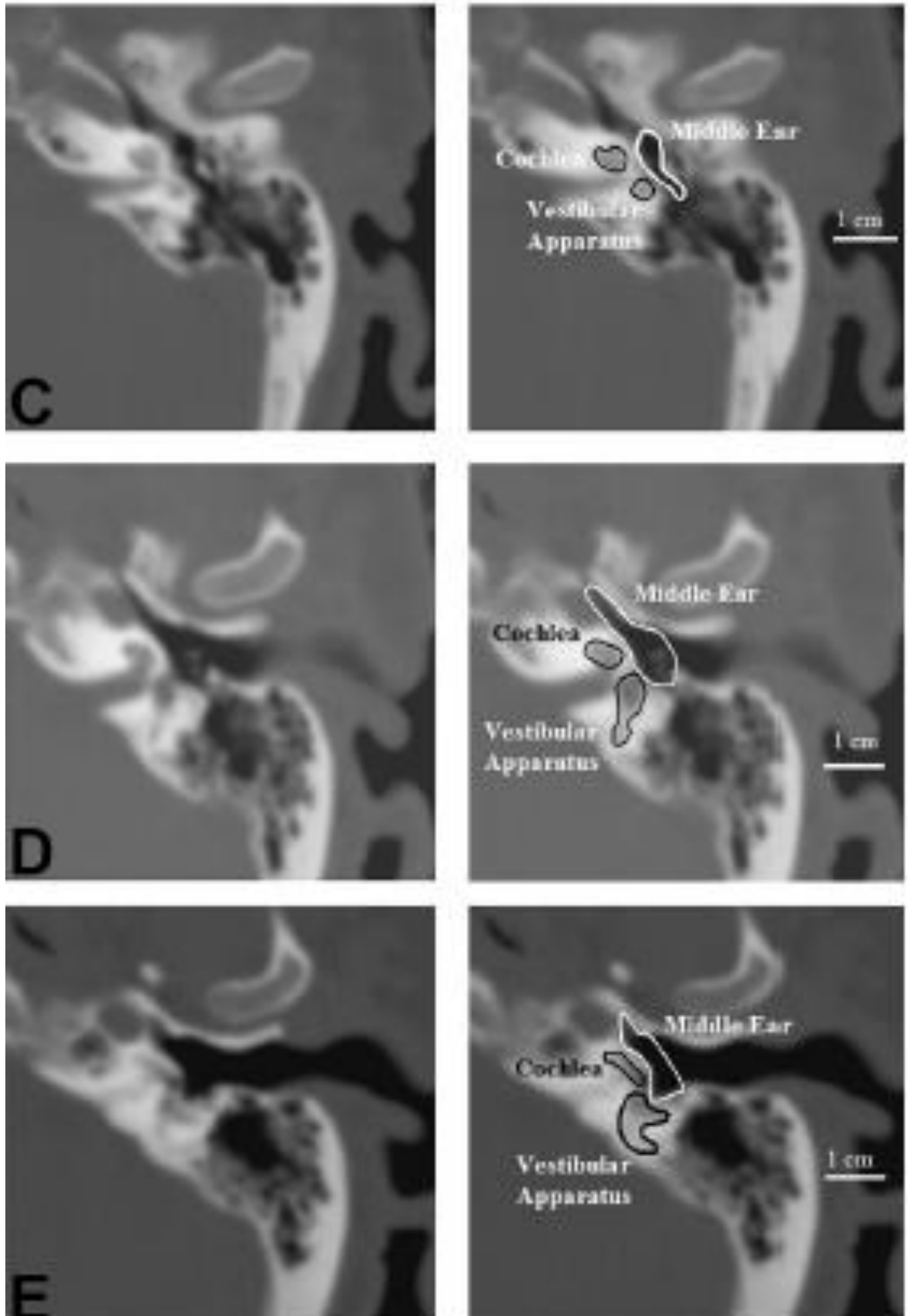
(*Am J Clin Oncol* 2005;28: 143–147)

Structures:

- Middle Ear
- IAC
- Semi-circular canal (Vestibular apparatus)
- Cochlea

3mm slice thickness


A
Internal auditory canal
Semi circular canal
This is part of a mastoid air cell
B
Middle Ear
Cochlea
Vestibular Apparatus



Middle Ear
Cochlea
Vestibular
Apparatus
1 cm
C
Middle Ear
Cochlea
Vestibular
Apparatus
1 cm
D
Middle Ear
Cochlea
Vestibular
Apparatus
1 cm
E

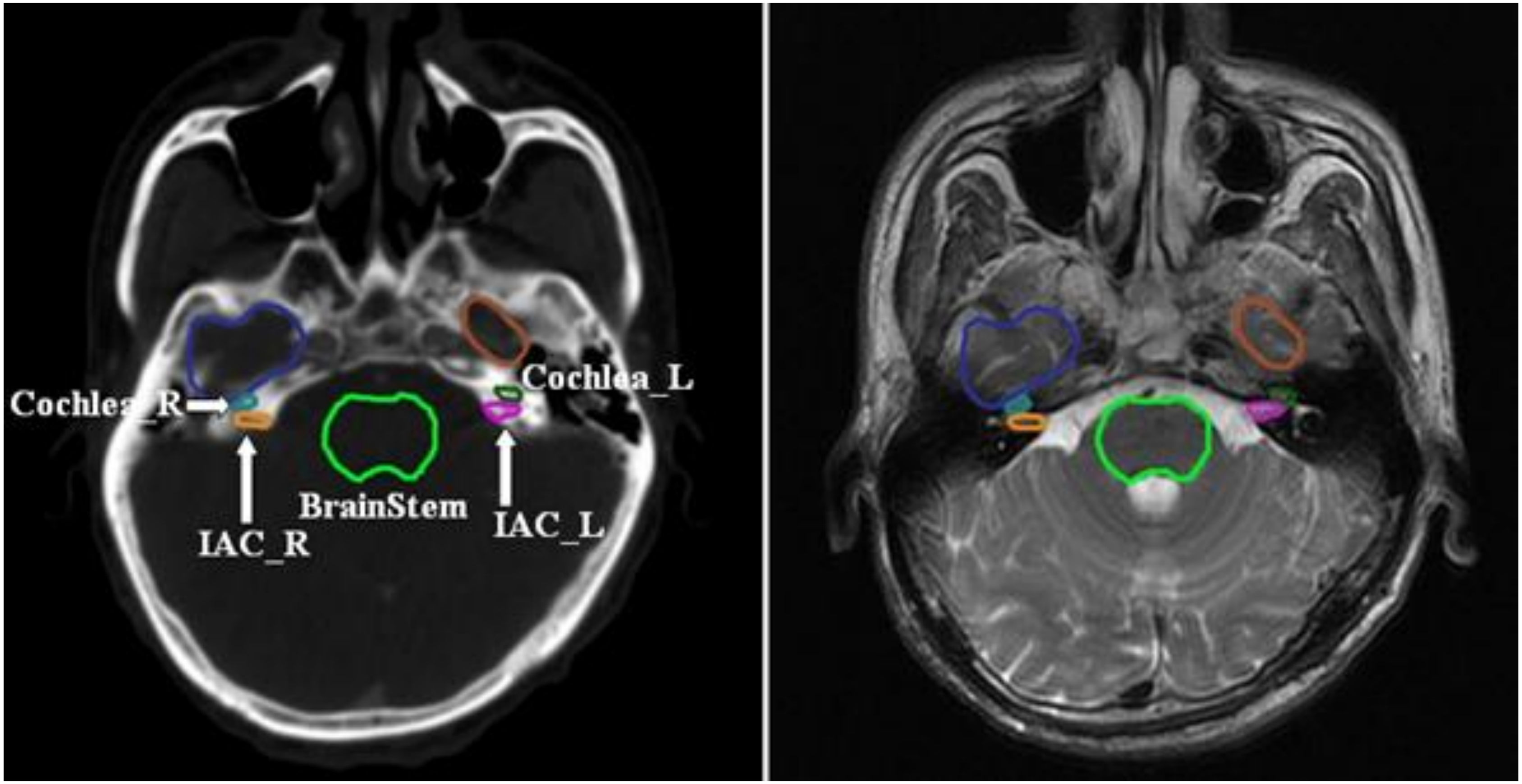
Recommendation for a contouring method and atlas of organs at risk in nasopharyngeal carcinoma patients receiving intensity-modulated radiotherapy

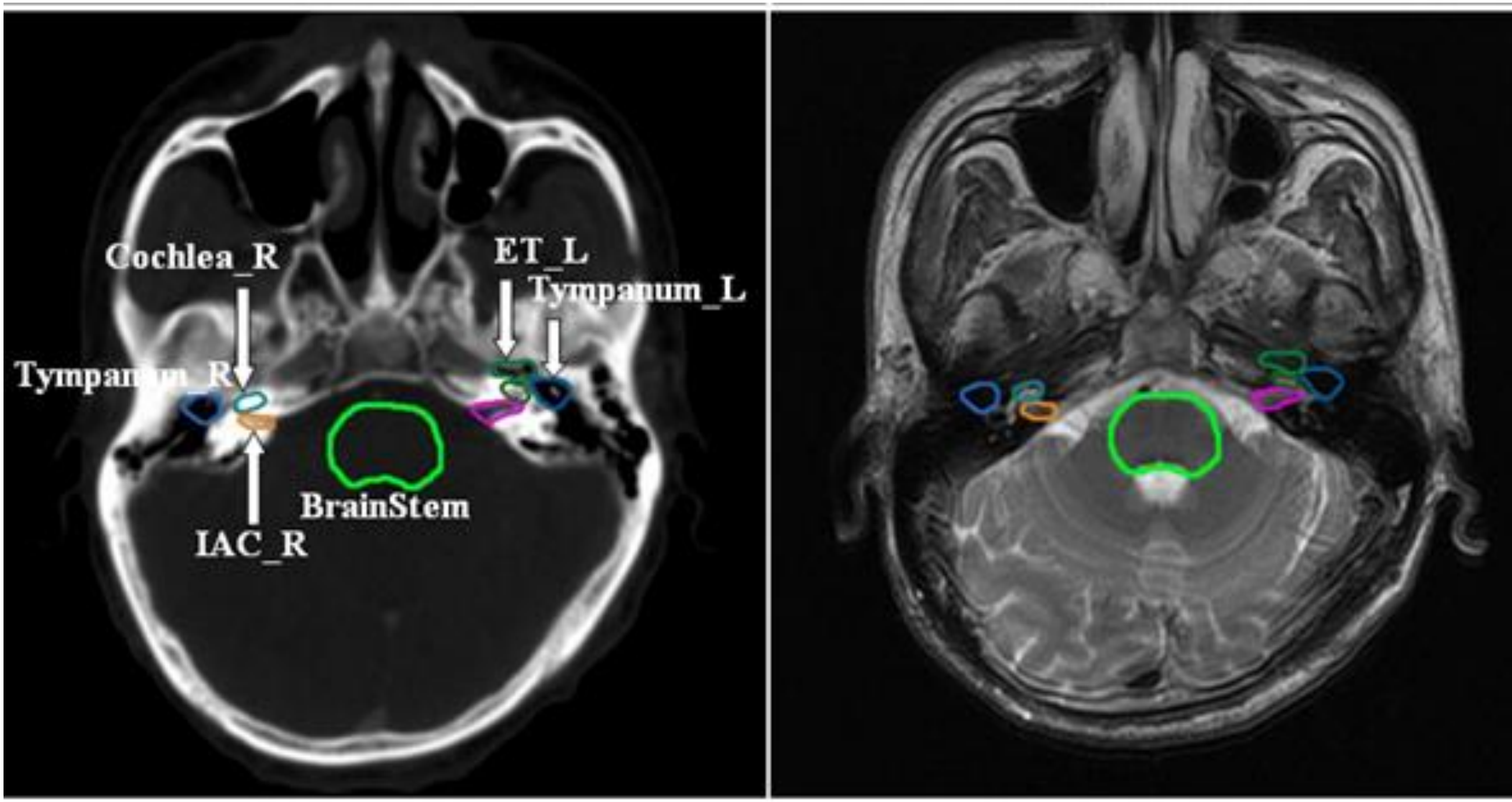
Ying Sun [a,1], Xiao-Li Yu [a,1], Wei Luo [a,1], Anne W.M. Lee [b,1], Joseph Tien Seng Wee [c,1], Nancy Lee [d,1], Guan-Qun Zhou [a], Ling-Long Tang [a], Chang-Juan Tao [a], Rui Guo [a], Yan-Ping Mao [a], Rong Zhang [e], Ying Guo [f], Jun Ma [a,*]

Radiotherapy and Oncology 110 (2014) 390–397

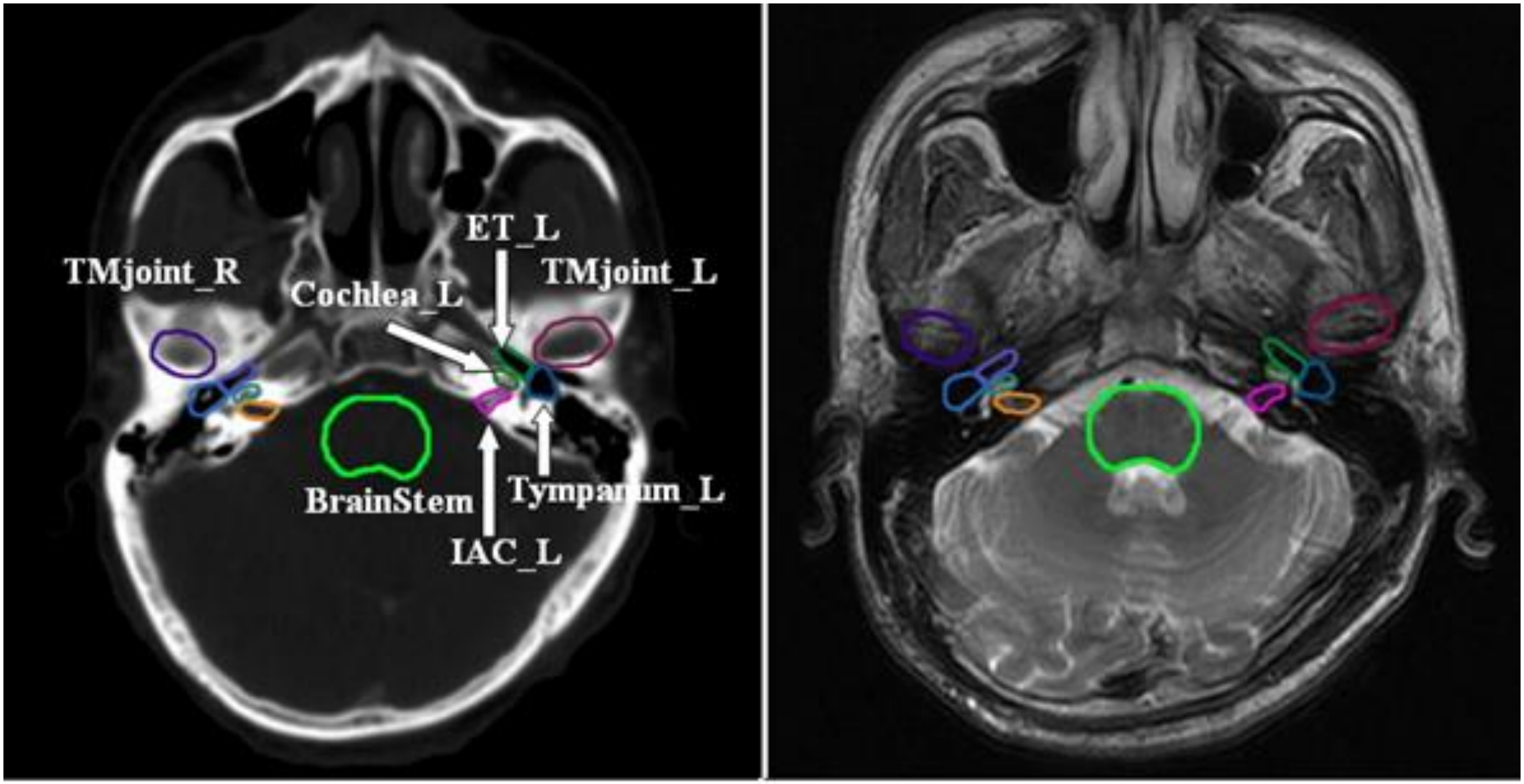
<u>OARs rel. to CNS:</u>

- Middle Ear – TM, ET
- Inner Ear – Cochlea, Vestibule, IAC
- Temporal Lobe


Cochlea_R
Cochlea_L
BrainStem
IAC_R
IAC_L



Cochlea_R
ET_L
Tympanum_L
Tympanum_R
BrainStem
IAC_R



ET_L
TMjoint_R
Cochlea_L
TMjoint_L
BrainStem
Tympanum_L
IAC_L

CT-based delineation of organs at risk in the head and neck region: DAHANCA, EORTC, GORTEC, HKNPCSG, NCIC CTG, NCRI, NRG Oncology and TROG consensus guidelines

Charlotte L. Brouwer [a,*,1], Roel J.H.M. Steenbakkers [a,1], Jean Bourhis [b], Wilfried Budach [c], Cai Grau [d], Vincent Grégoire [e], Marcel van Herk [f], Anne Lee [g], Philippe Maingon [h], Chris Nutting [i], Brian O'Sullivan [j], Sandro V. Porceddu [k], David I. Rosenthal [l], Nanna M. Sijtsema [a], Johannes A. Langendijk [a]

Radiotherapy and Oncology 117 (2015) 83–90

2mm slice thickness

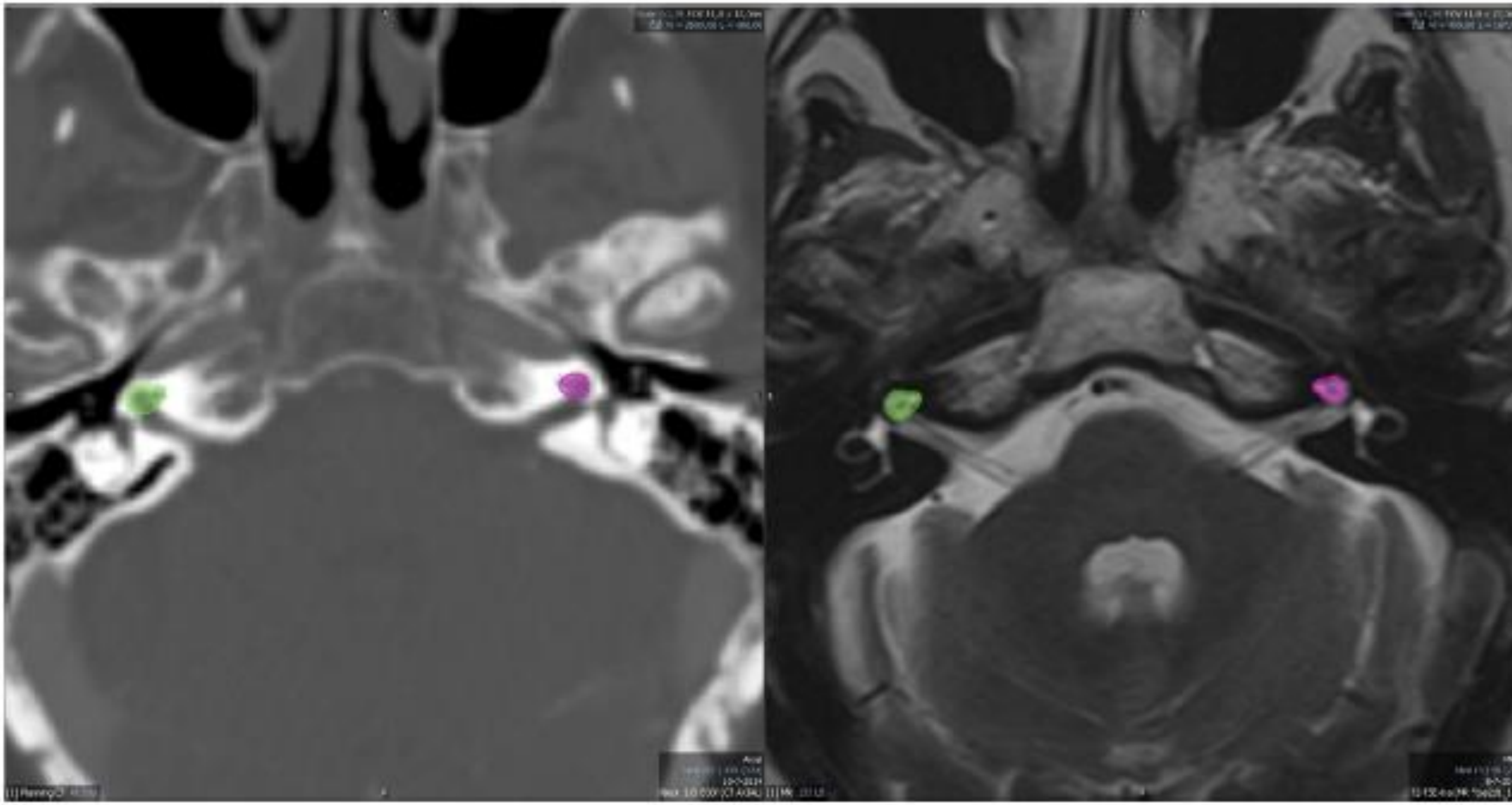


Fig. 2. Delineation of the cochlea in CT bone settings (left), matched to MRI-T2 (right).

TEMPORAL LOBE

Recommendation for a contouring method and atlas of organs at risk in nasopharyngeal carcinoma patients receiving intensity-modulated radiotherapy

Ying Sun [a,1], Xiao-Li Yu [a,1], Wei Luo [a,1], Anne W.M. Lee [b,1], Joseph Tien Seng Wee [c,1], Nancy Lee [d,1], Guan-Qun Zhou [a], Ling-Long Tang [a], Chang-Juan Tao [a], Rui Guo [a], Yan-Ping Mao [a], Rong Zhang [e], Ying Guo [f], Jun Ma [a,*]

Radiotherapy and Oncology 110 (2014) 390–397

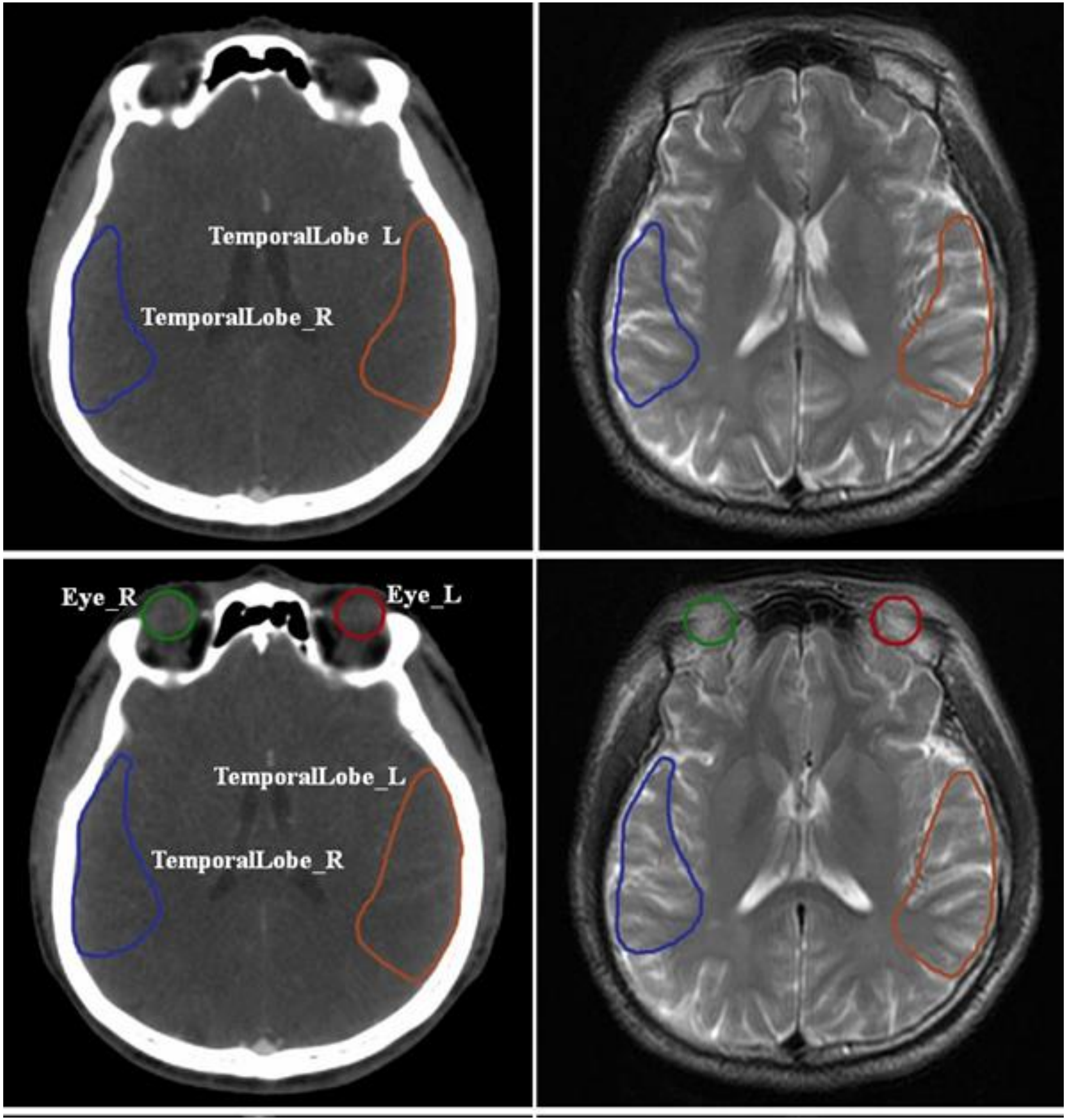
Method 1

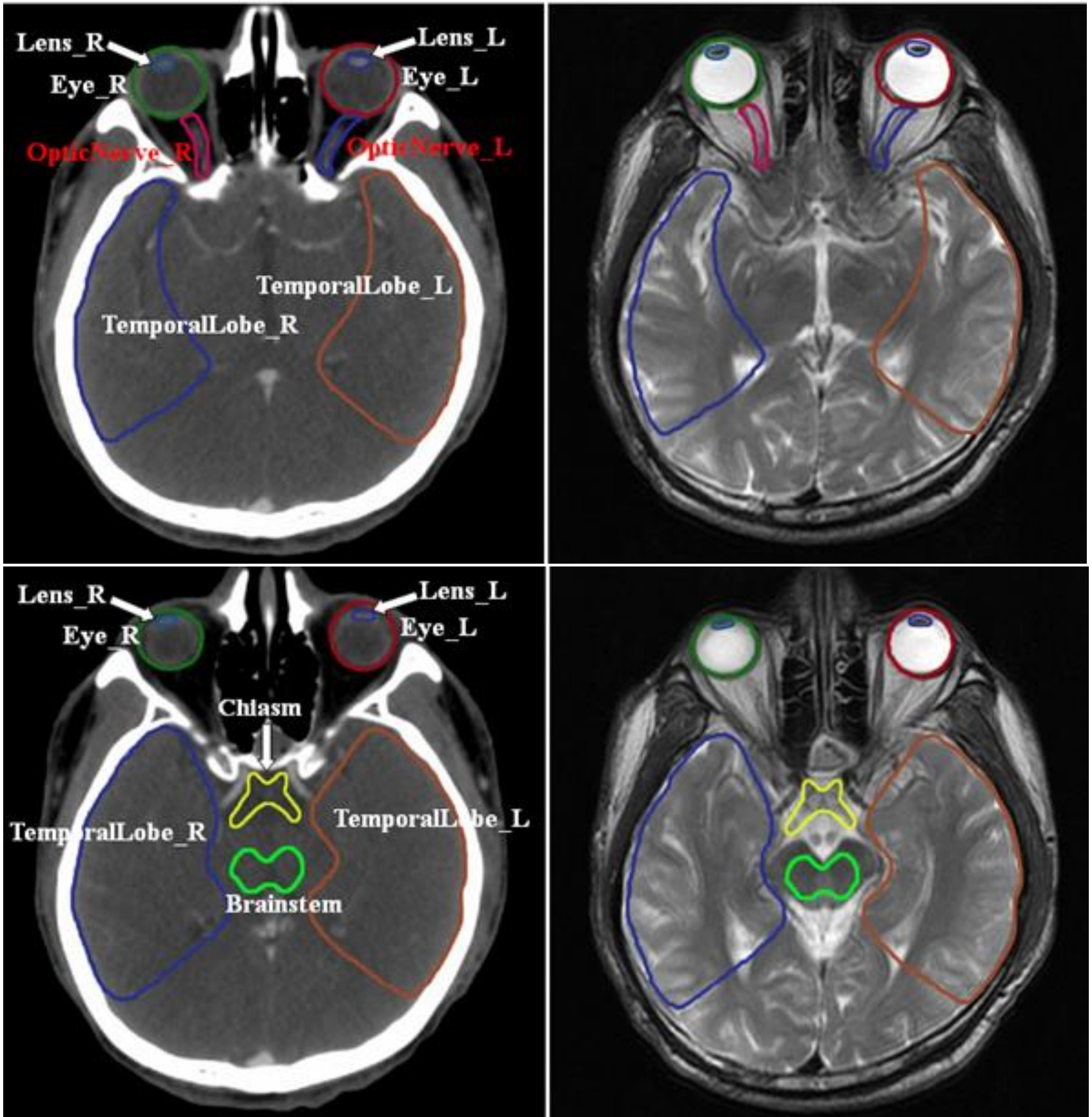
Temporal lobe excluding parahippocampal gyrus and hippocampus, including the basal ganglia and insula.

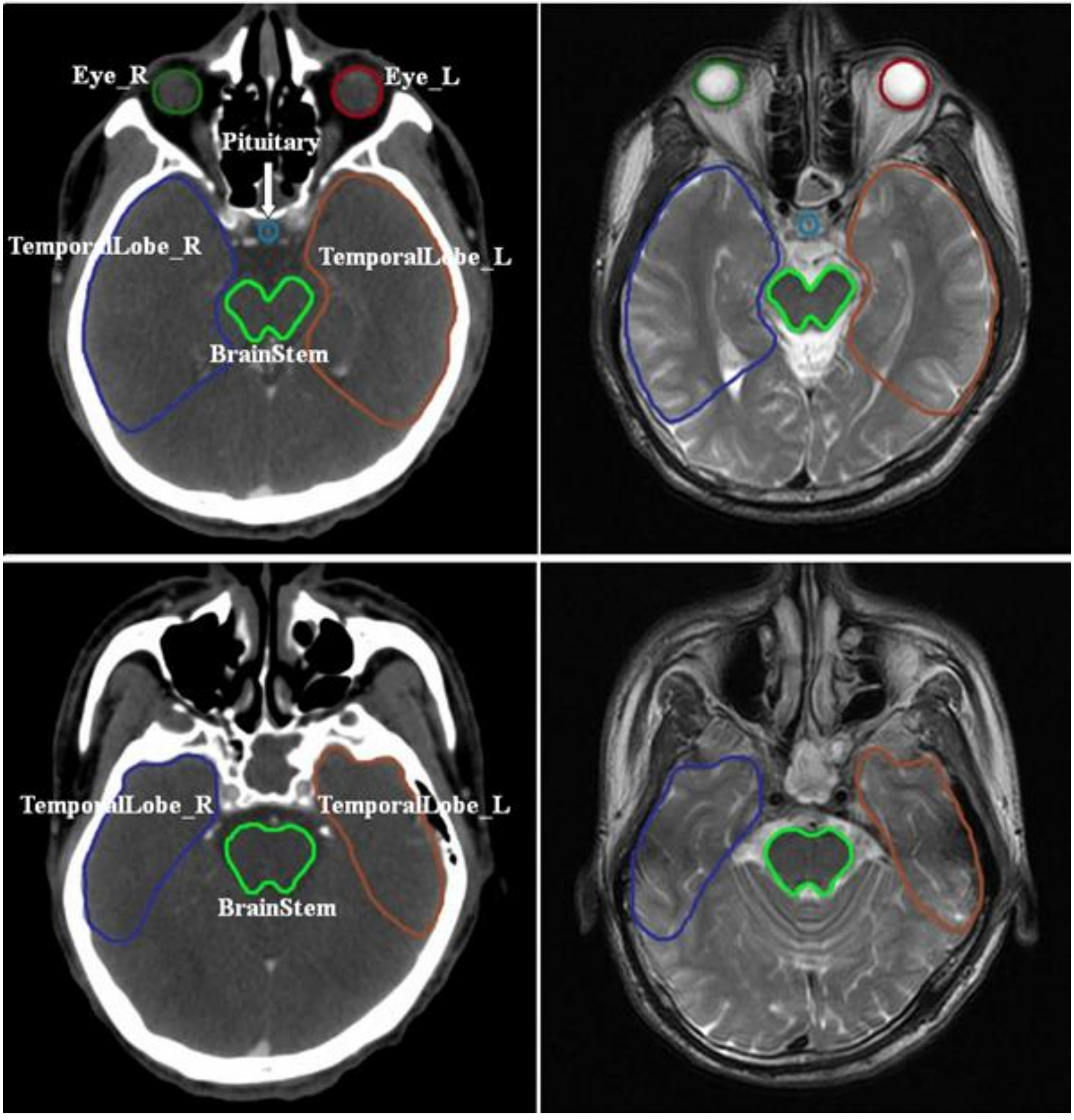
Method 2

Authors' preference

Temporal lobe including parahippocampal gyrus and hippocampus, excluding the basal ganglia and insula.


TemporalLobe_L
TemporalLobe_R
Eye_R
Eye_L
TemporalLobe_L
TemporalLobe_R


Lens_R
Lens_L
Eye_R
Eye_L
OpticNerve_R
OpticNerve_L
TemporalLobe_L
TemporalLobe_R
Lens_R
Lens_L
Eye_R
Eye_L
Chiasm
TemporalLobe_R
TemporalLobe_L
Brainstem



Eye_R
Eye_L
Pituitary
TemporalLobe_R
TemporalLobe_L
BrainStem
TemporalLobe_R
TemporalLobe_L
BrainStem

HIPPOCAMPUS

HIPPOCAMPAL-SPARING WHOLE-BRAIN RADIOTHERAPY: A "HOW-TO" TECHNIQUE USING HELICAL TOMOTHERAPY AND LINEAR ACCELERATOR–BASED INTENSITY-MODULATED RADIOTHERAPY

VINAI GONDI, M.D.,* RANJINI TOLAKANAHALLI, M.S.,† MINESH P. MEHTA, M.D.,*
DINESH TEWATIA, M.S.,*† HOWARD ROWLEY, M.D.,‡ JOHN S. KUO, M.D., PH.D.,*§
DEEPAK KHUNTIA, M.D.,* AND WOLFGANG A. TOMÉ, PH.D.*†

Int. J. Radiation Oncology Biol. Phys., Vol. 78, No. 4, pp. 1244–1252, 2010

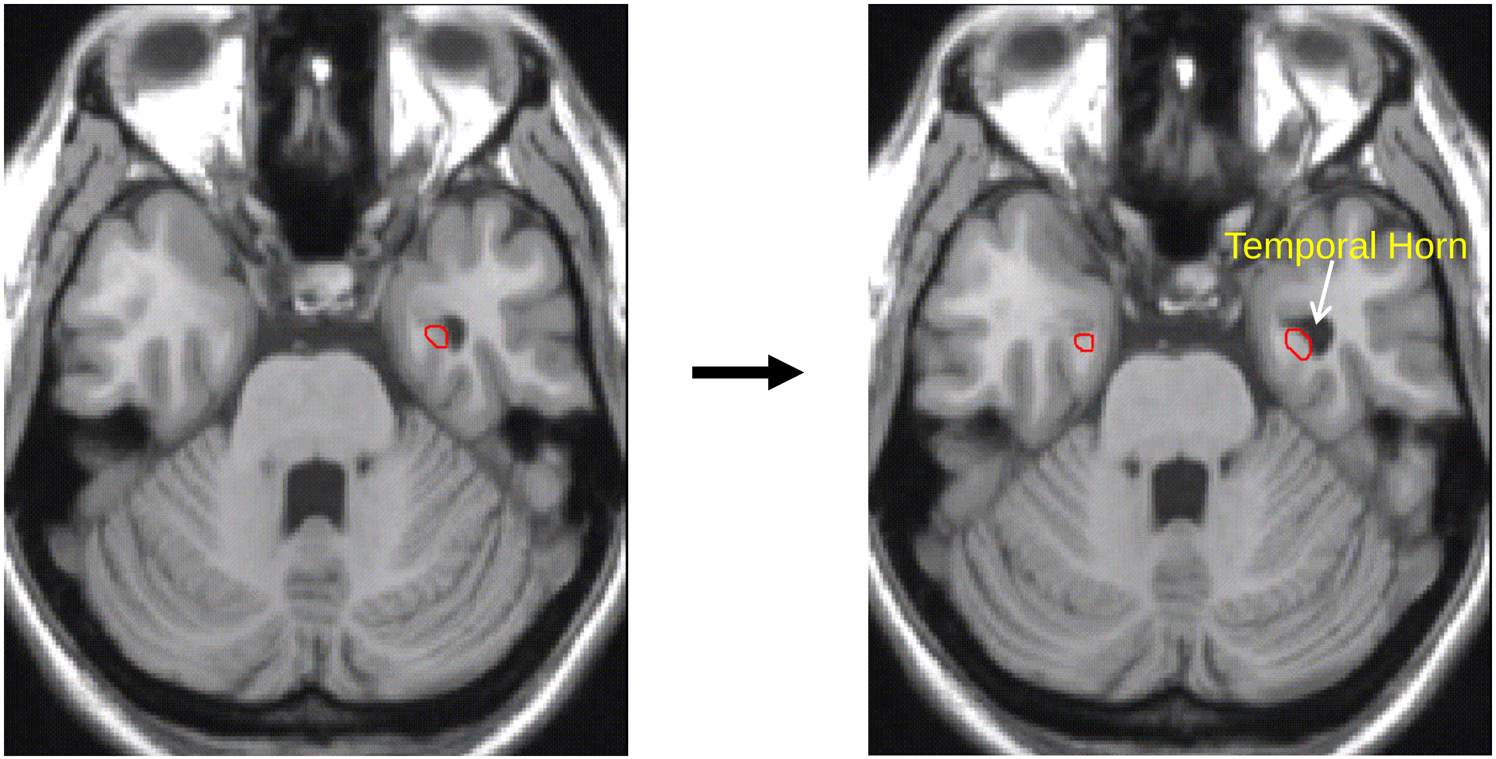
+

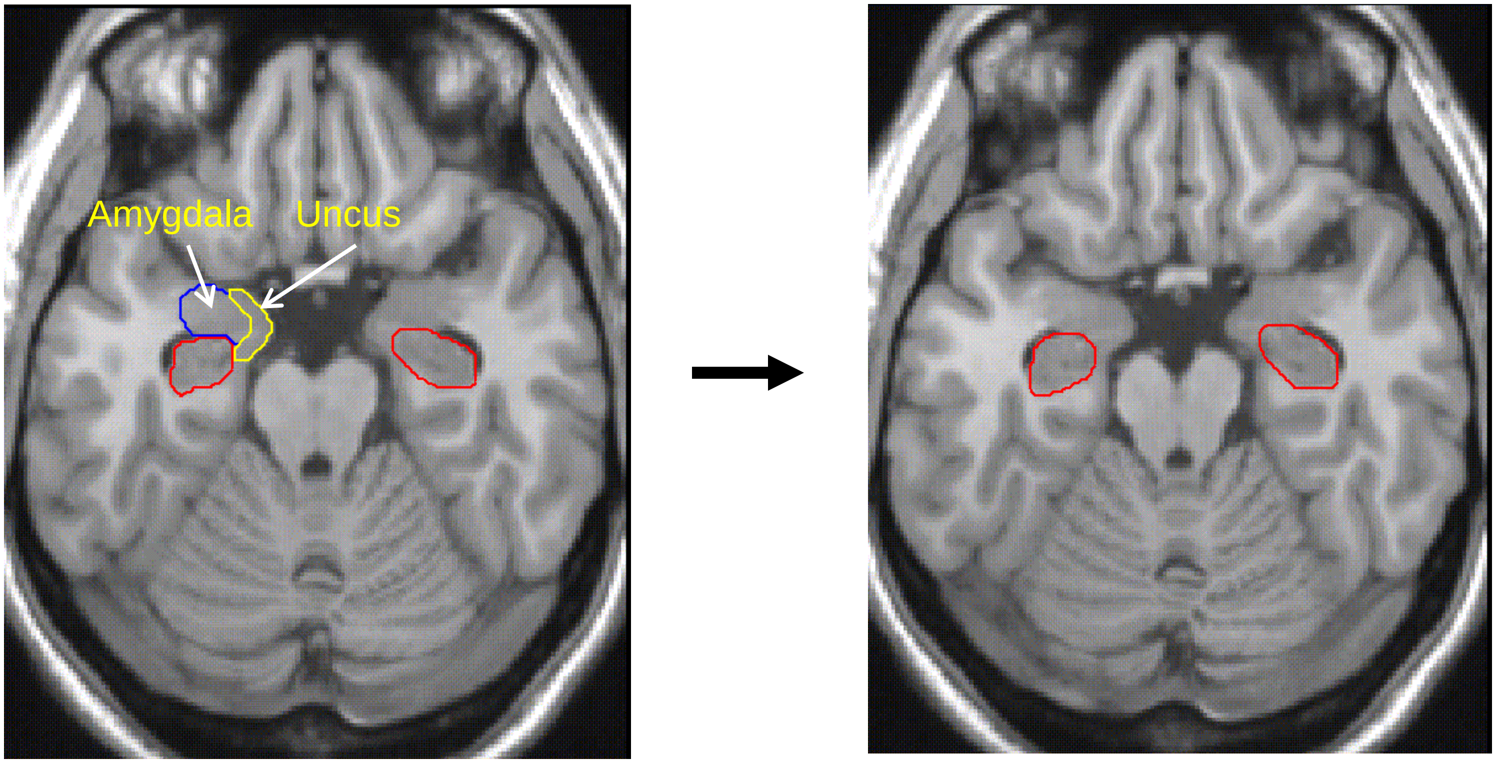
Hippocampal Contouring: A Contouring Atlas for RTOG 0933 (Ph II study)

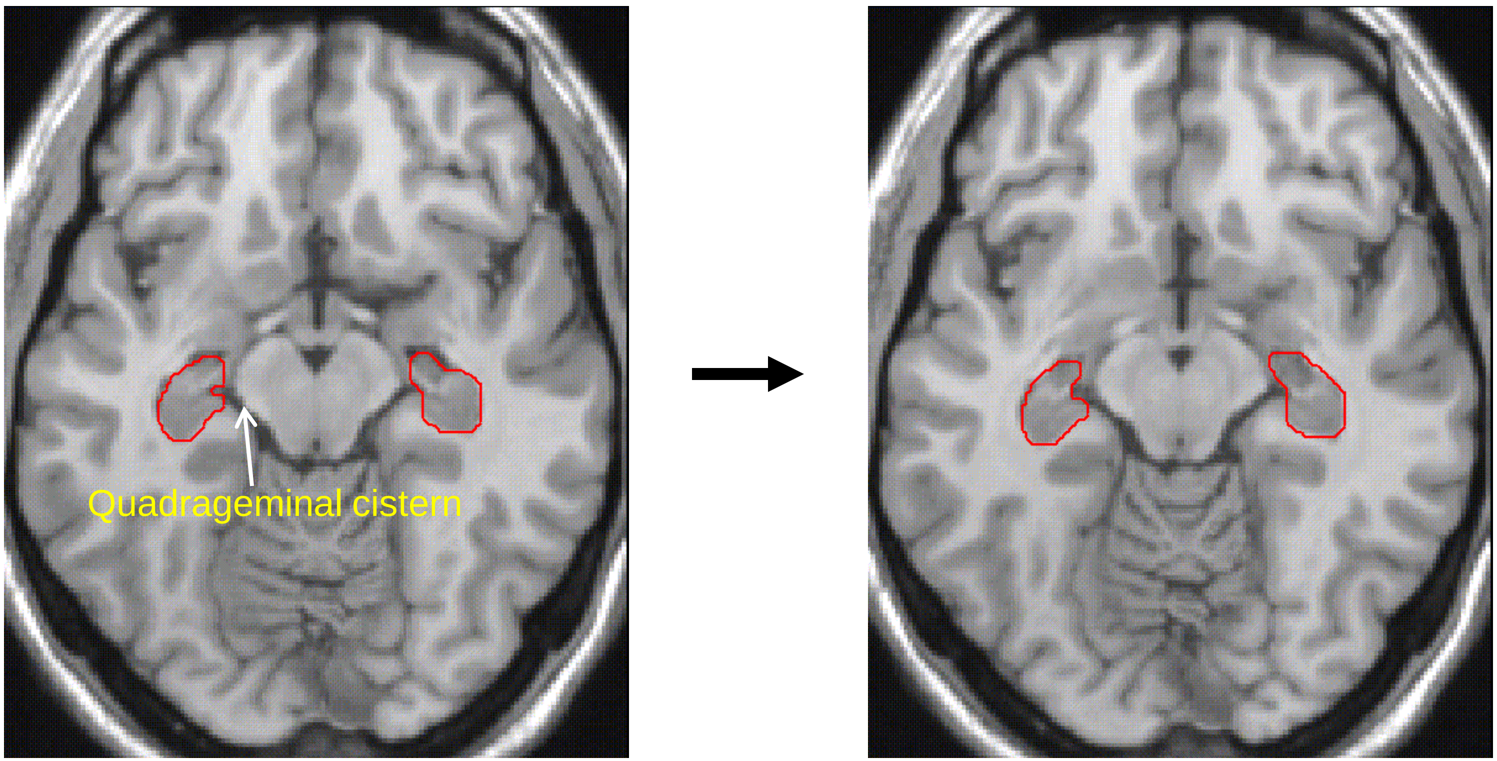
(Source: RTOG website, atlases)

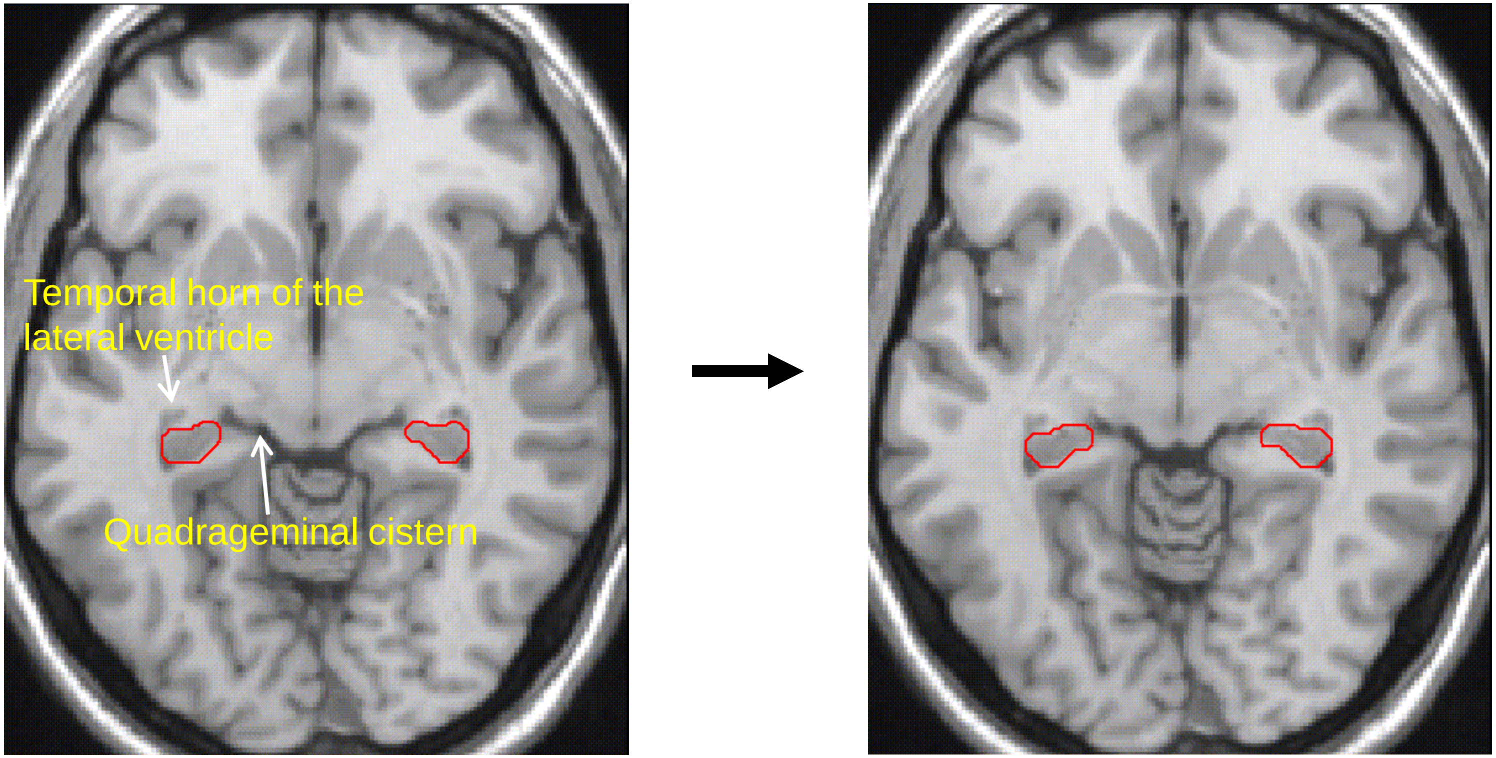
Patients underwent a noncontrast computed tomography (CT) simulation scan of the entire head region with 1.25-mm slice thickness using an aquaplast mask for immobilization. Within 2 weeks before treatment, the patients underwent three-dimensional spoiled gradient axial magnetic resonance imaging (MRI) scans (3D-SPGR) with standard axial and coronal fluid attenuation recovery (FLAIR), axial T2-weighted and gadolinium contrast-enhanced T1-weighted sequence acquisitions with a 1.25-mm slice thickness (Stealth MRI). The CT simulation and Stealth MRI scans were fused semi-automatically.

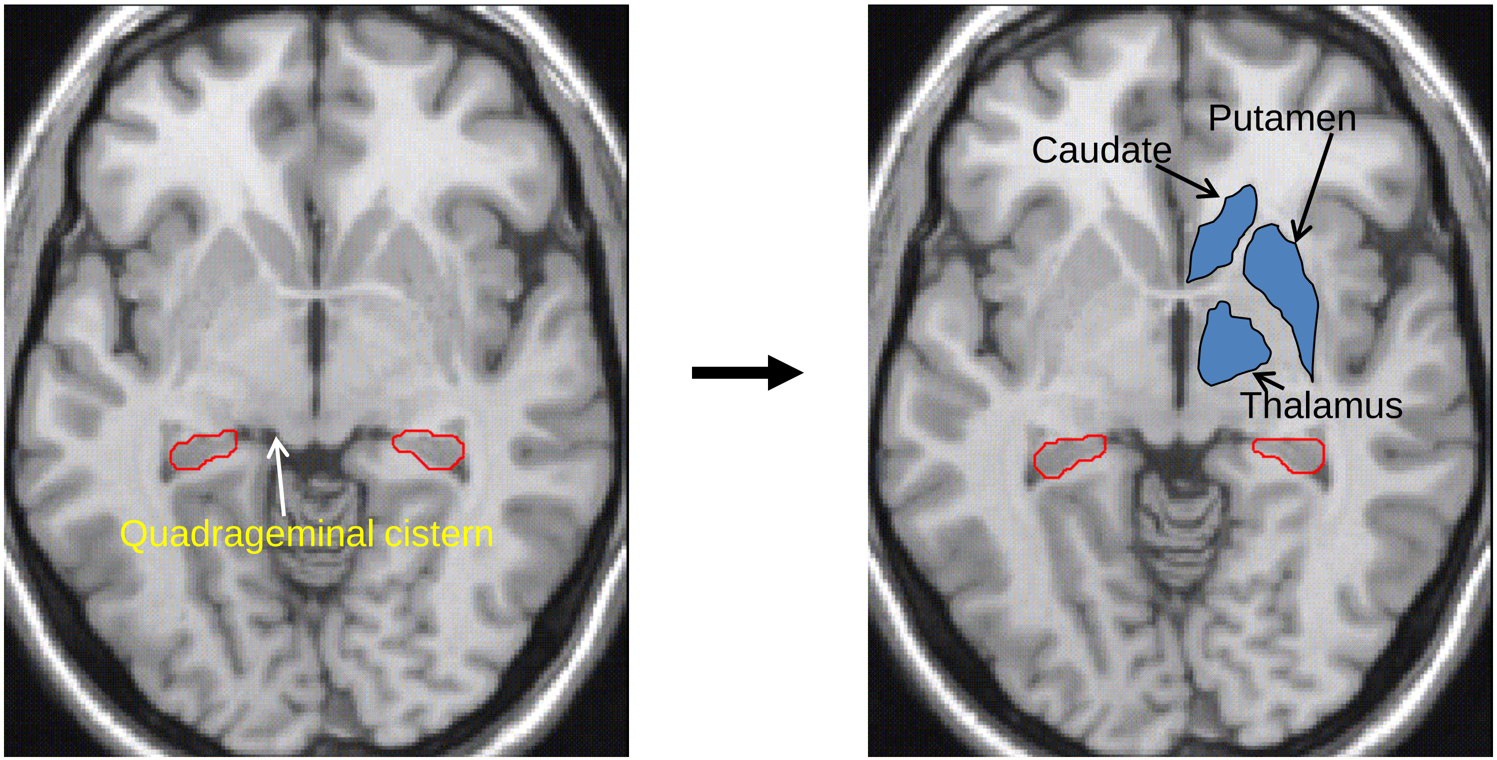
Hippocampus was contoured on T1-weighted axial MR images – focused on ***not*** contouring the whole organ but mostly the SGZ (subgranular zone).

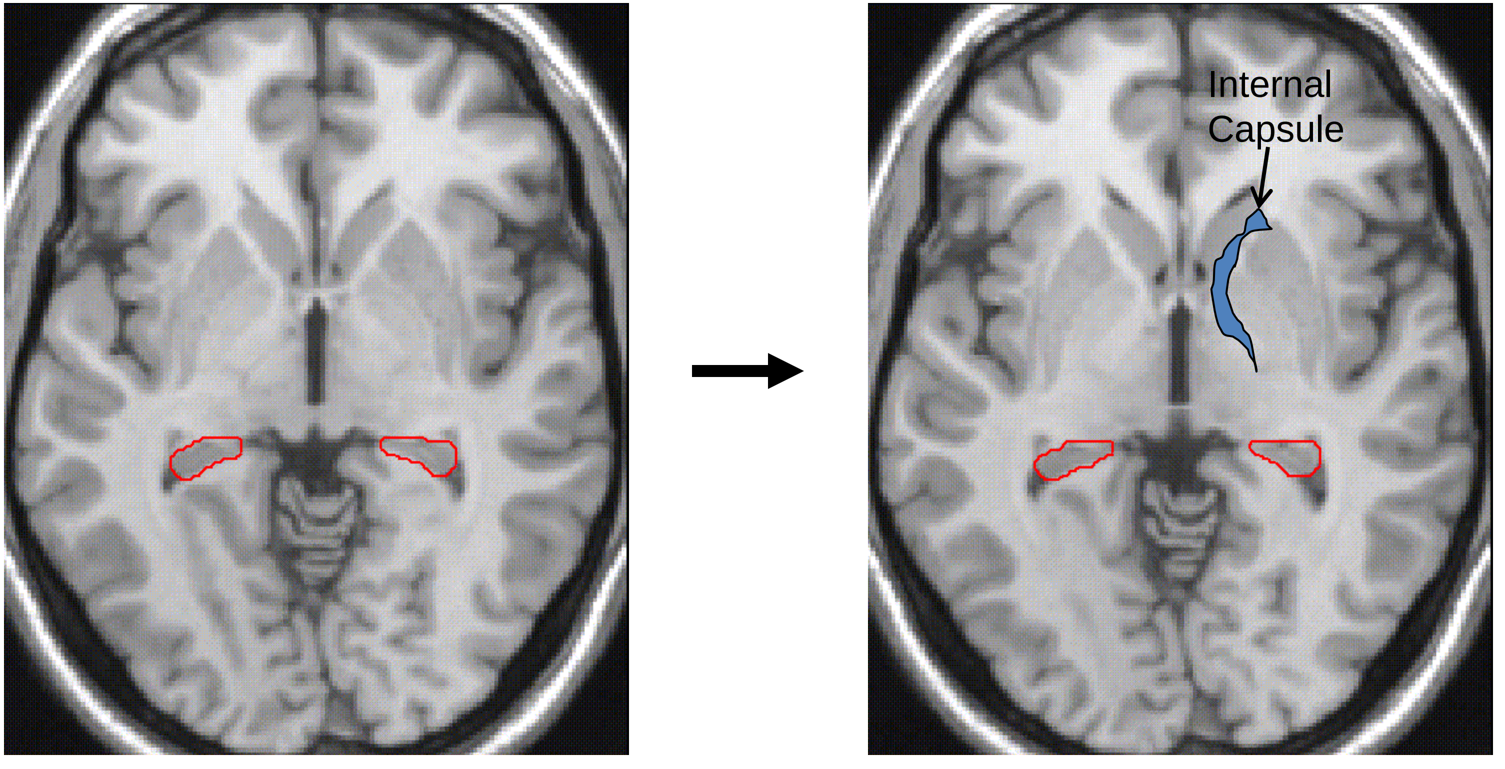

Temporal Horn

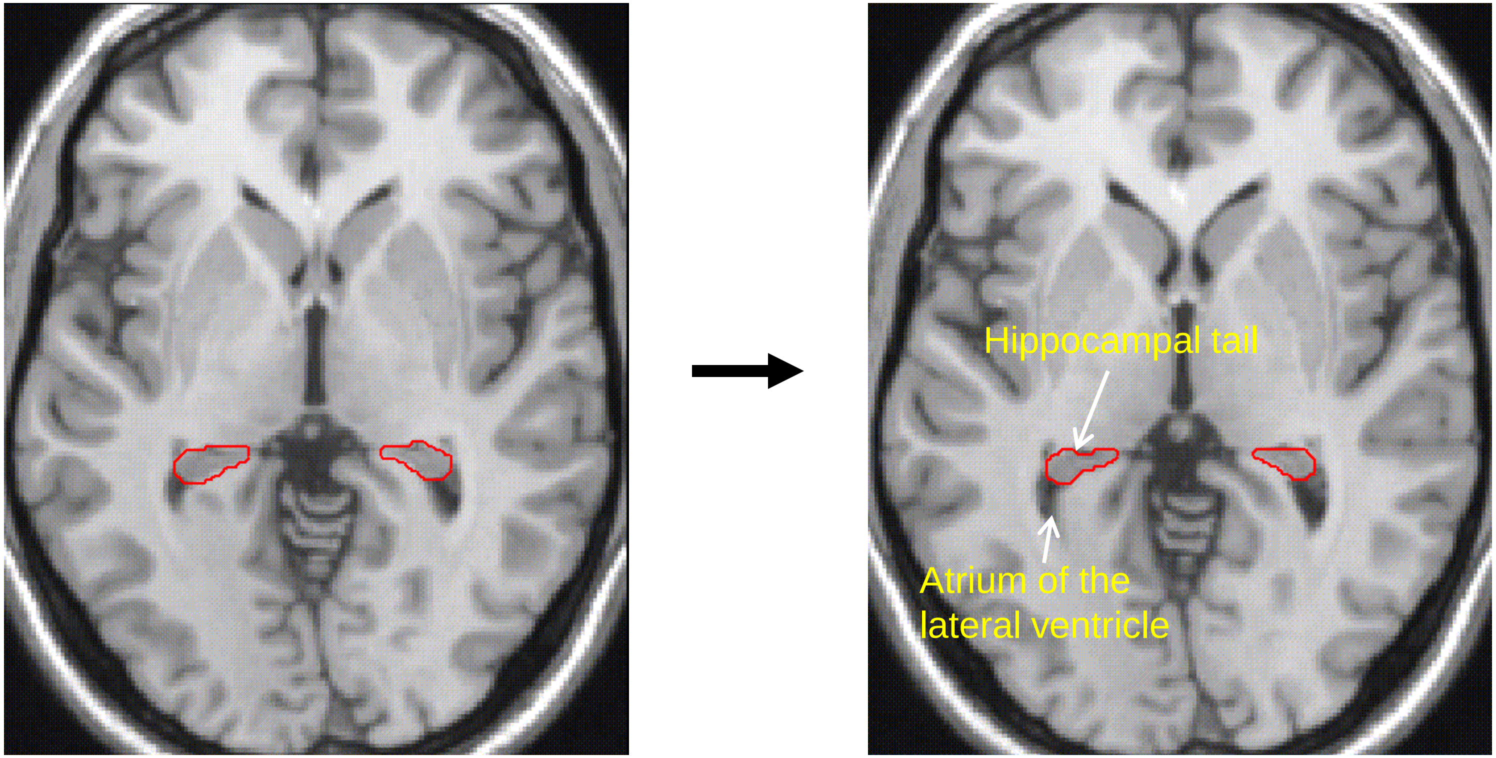

Amygdala
Uncus

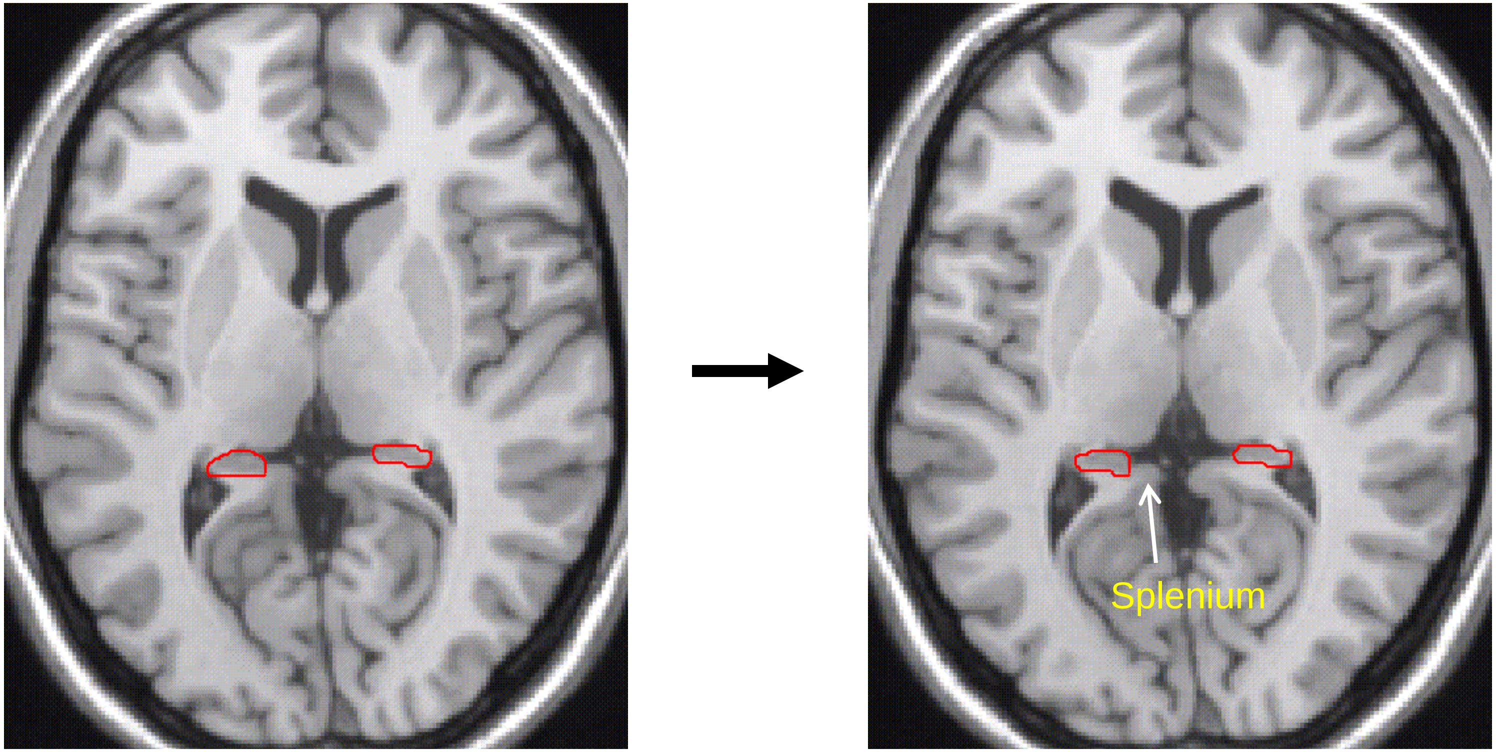

Quadrageminal cistern

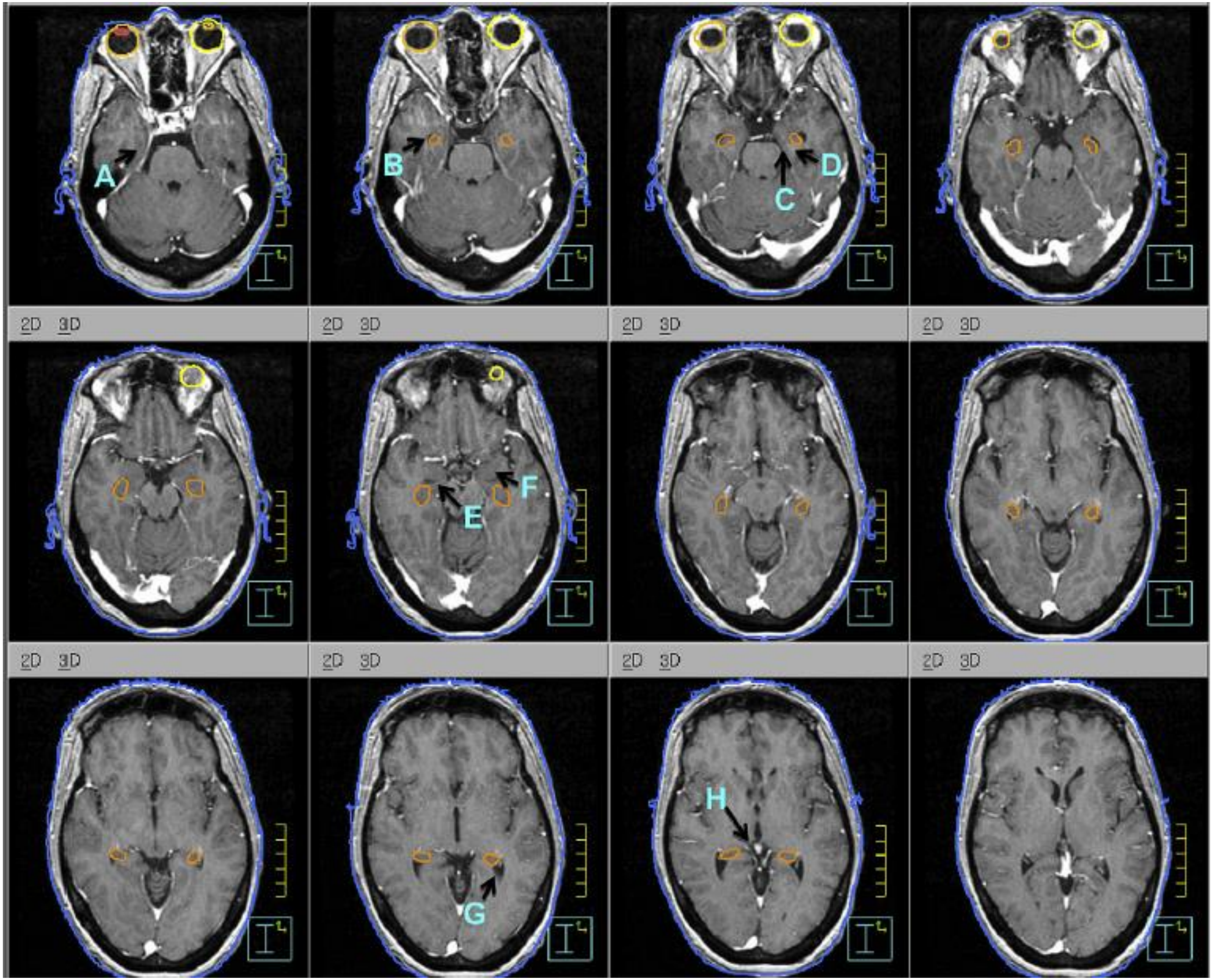

Temporal horn of the
lateral ventricle
Quadrageminal cistern


Quadrageminal cistern
Putamen
Caudate
Thalamus


Internal
Capsule


Hippocampal tail
Atrium of the
lateral ventricle


Splenium


A
B
C
D
E
F
G
H
2D 3D

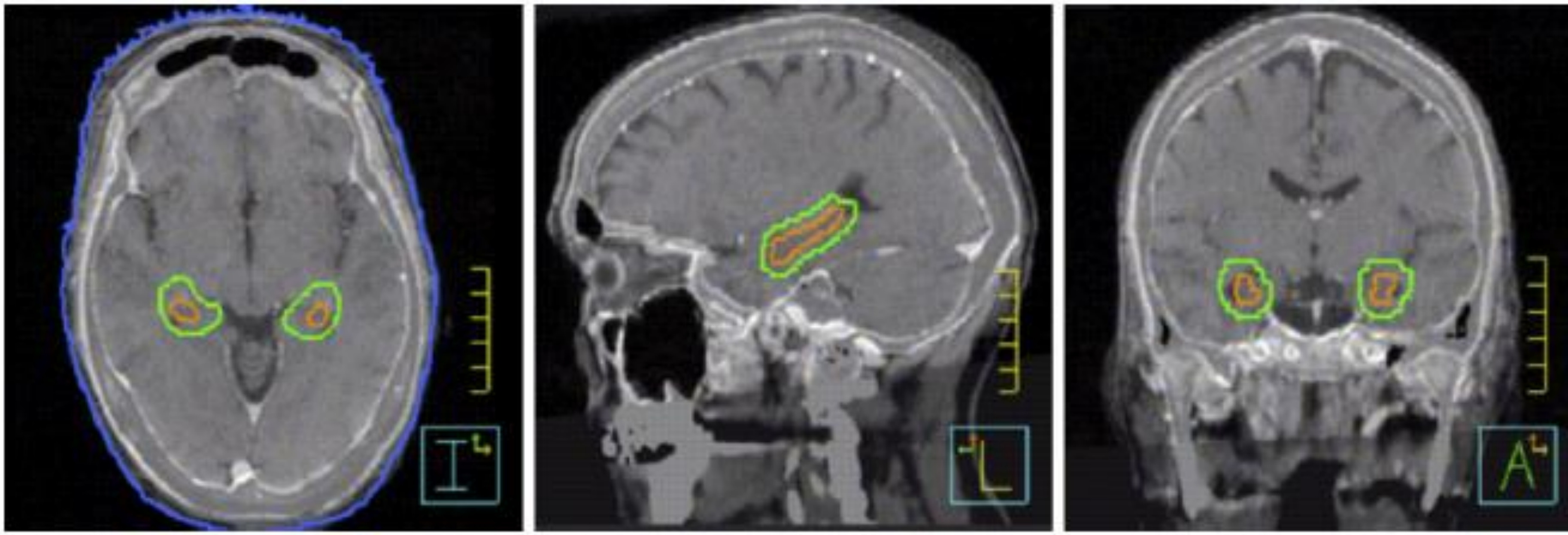


Fig. 2. Hippocampal avoidance region. The hippocampal avoidance region (green) was generated by expanding the hippocampal contour (orange) by 5 mm volumetrically to account for setup error. Appropriate anatomical contouring was confirmed using T1-weighted magnetic resonance imaging (MRI) sagittal and coronal sequences.

Few imp./interesting sources/references

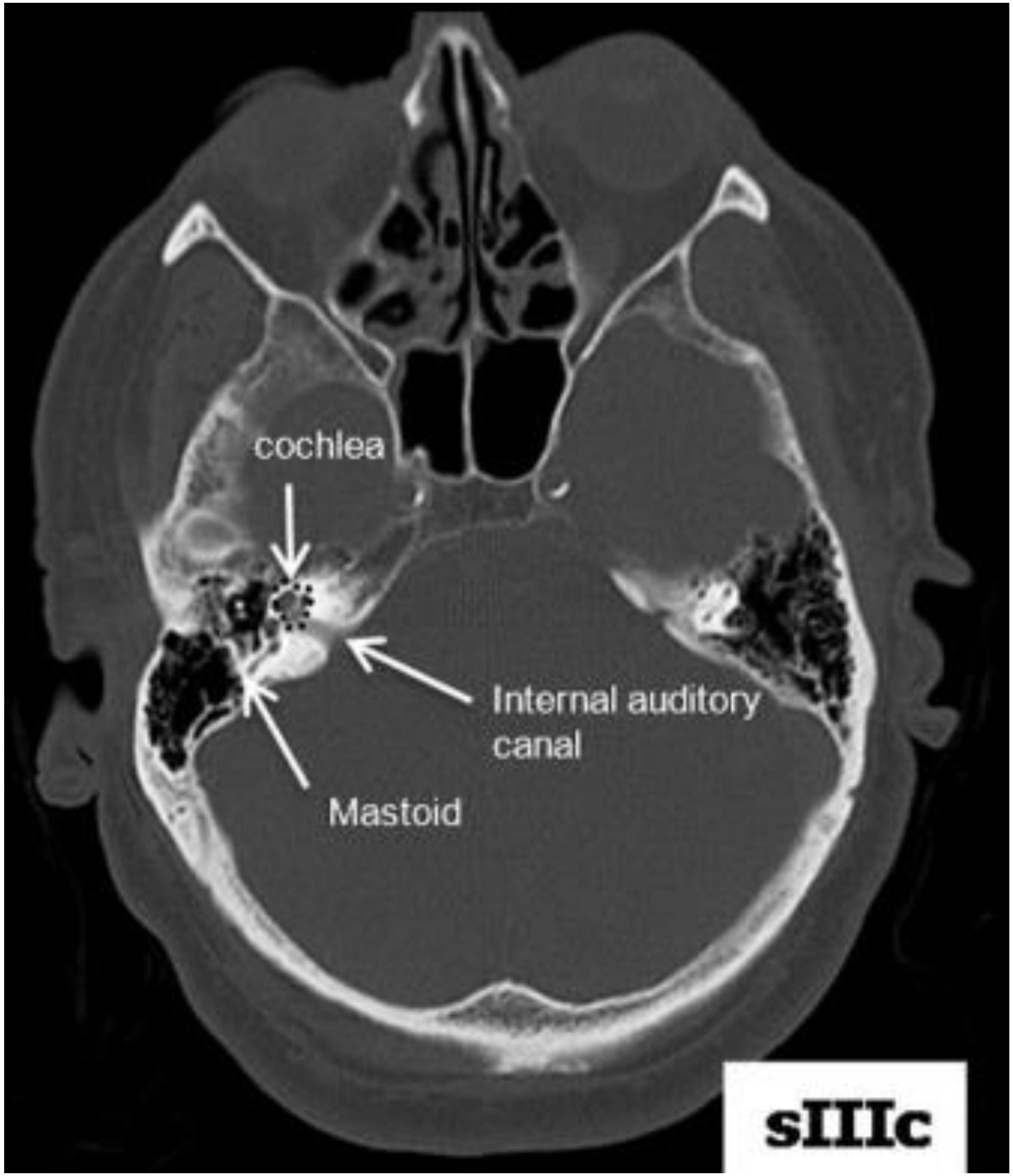
Organs at risk in the brain and their dose-constraints in adults and in children: A radiation oncologist's guide for delineation in everyday practice

Silvia Scoccianti [a,*], Beatrice Detti [a], Davide Gadda [b], Daniela Greto [a], Ilaria Furfaro [a], Fiammetta Meacci [a], Gabriele Simontacchi [a], Lucia Di Brina [a], Pierluigi Bonomo [a], Irene Giacomelli [a], Icro Meattini [a], Monica Mangoni [a], Sabrina Cappelli [a], Sara Cassani [a], Cinzia Talamonti [c], Lorenzo Bordi [d], Lorenzo Livi [a]

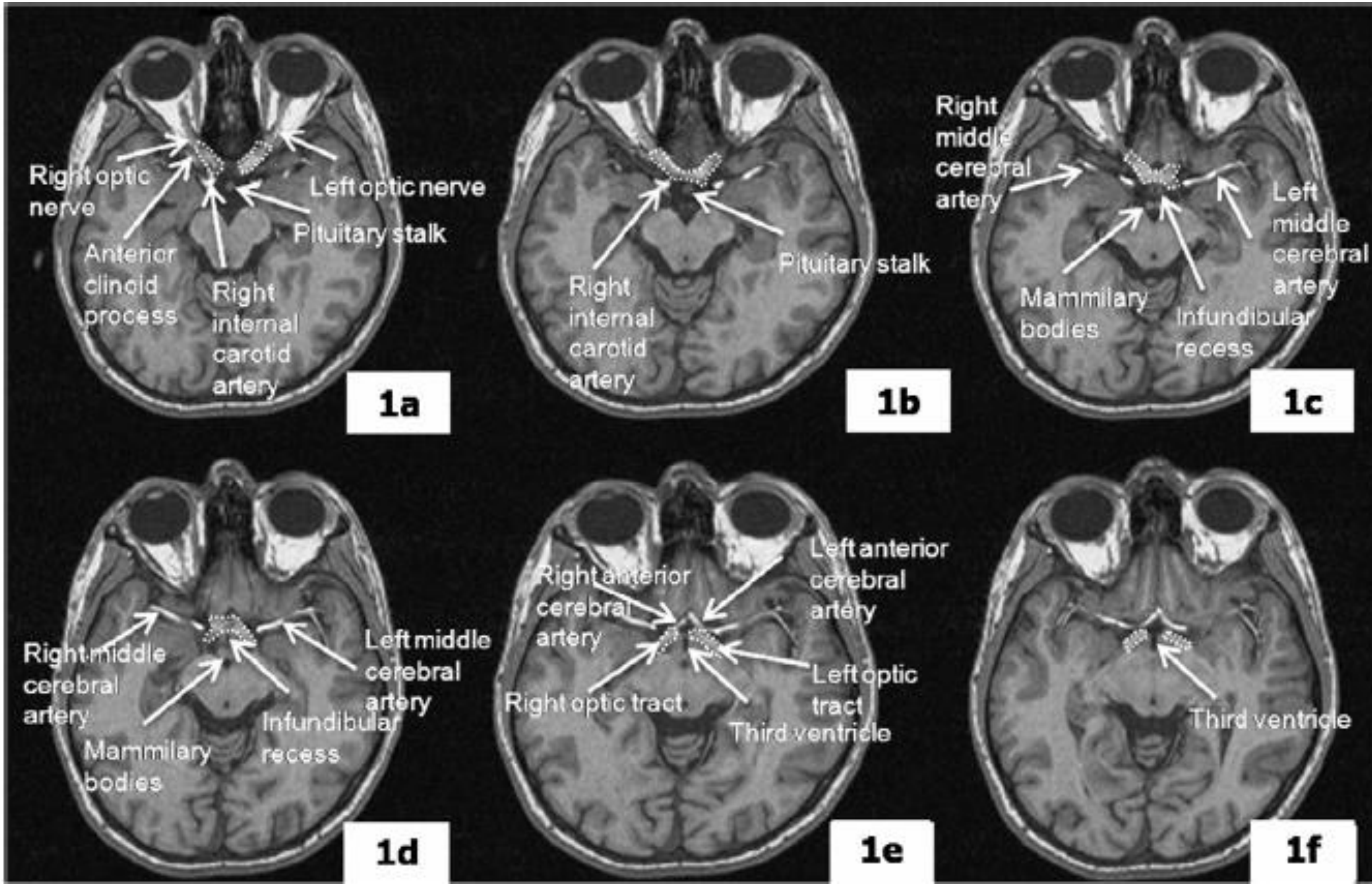
Radiotherapy and Oncology 114 (2015) 230–238

OARs:

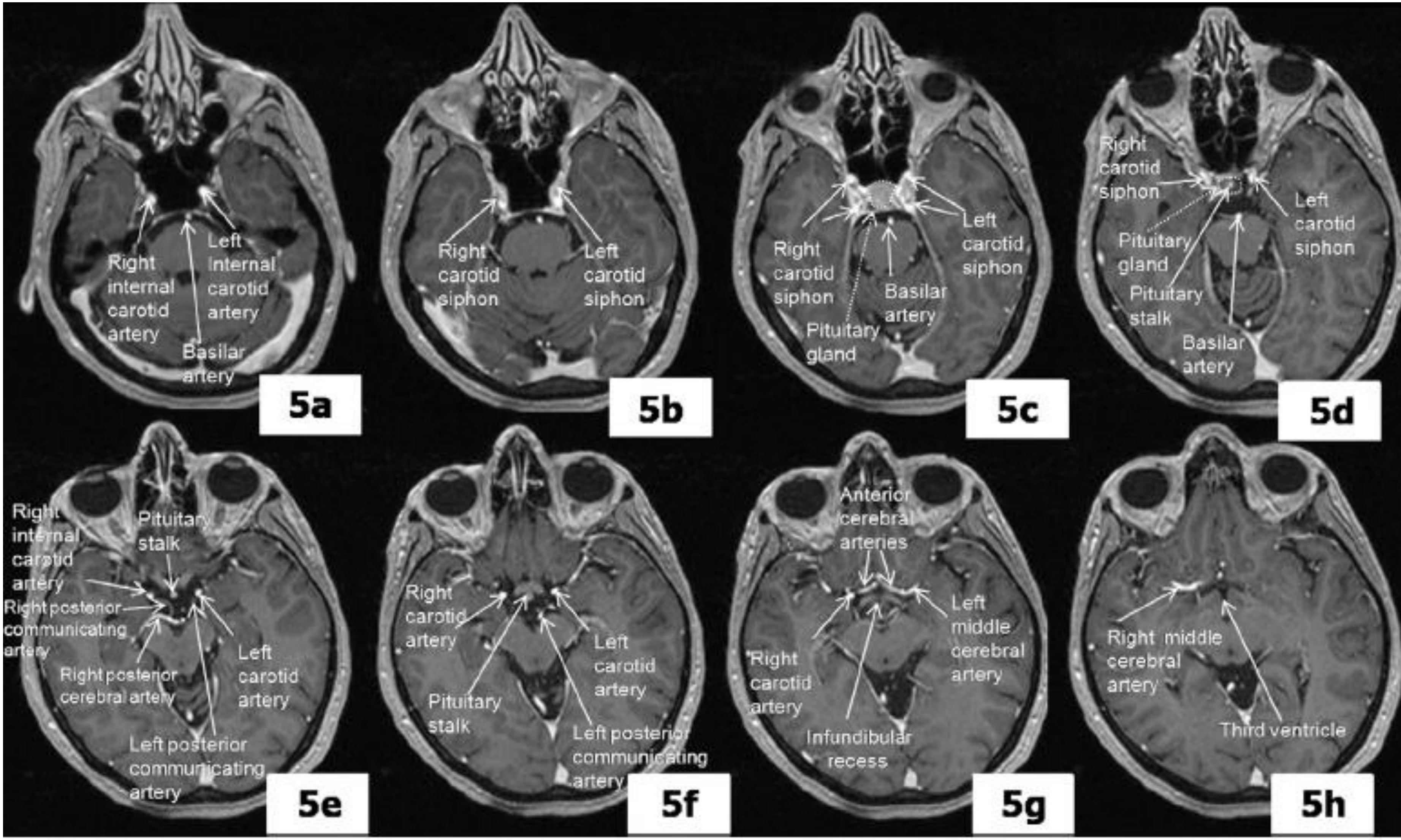
- Optic nerves
- Optic chiasma
- Cochlea
- IAC
- Brainstem
- Pituitary gland
- Hippocampus
- Retina
- Lacrimal gland
- Lens



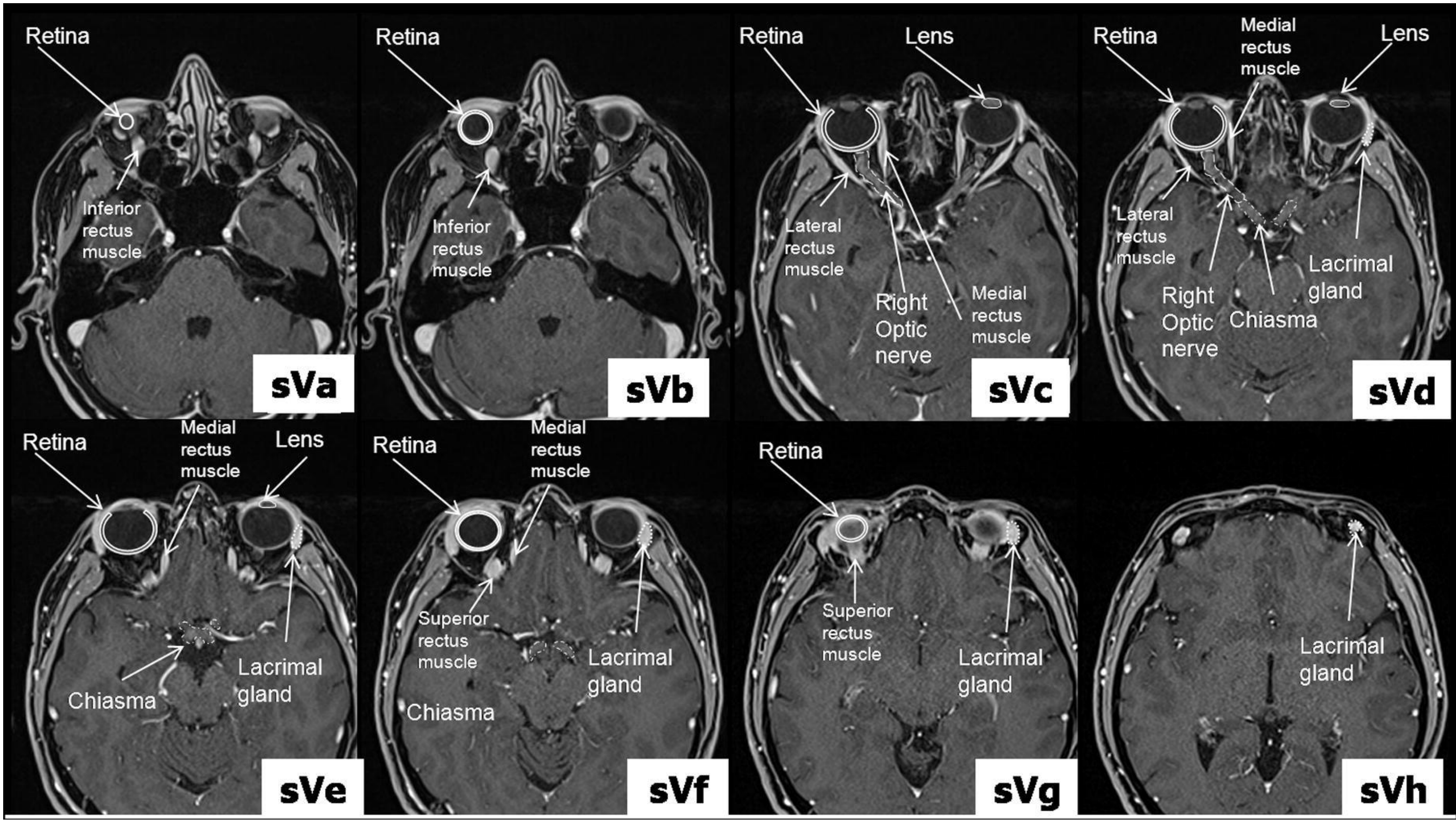
Cochlea & IAC



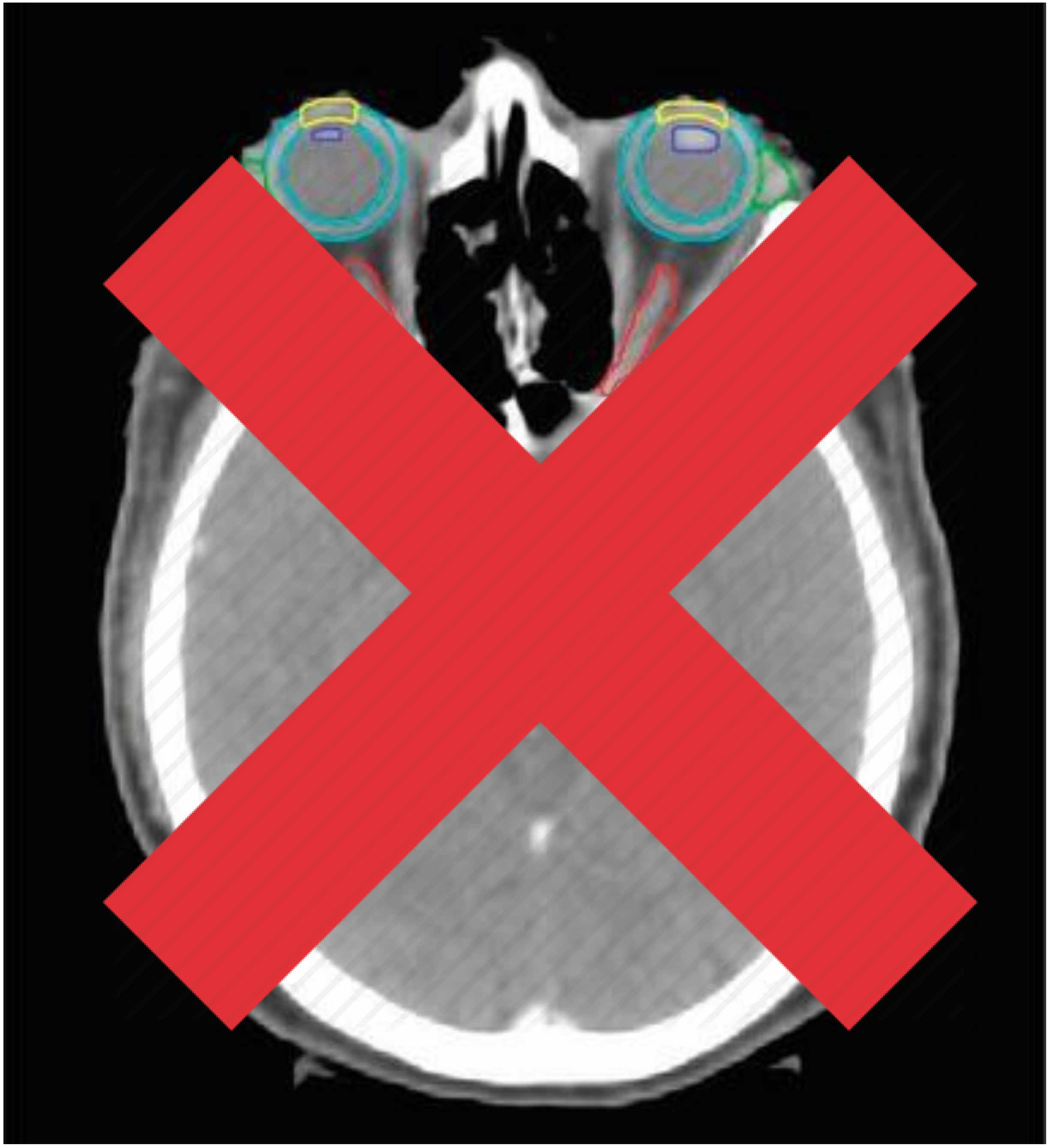
Opt. Nn & chiasm

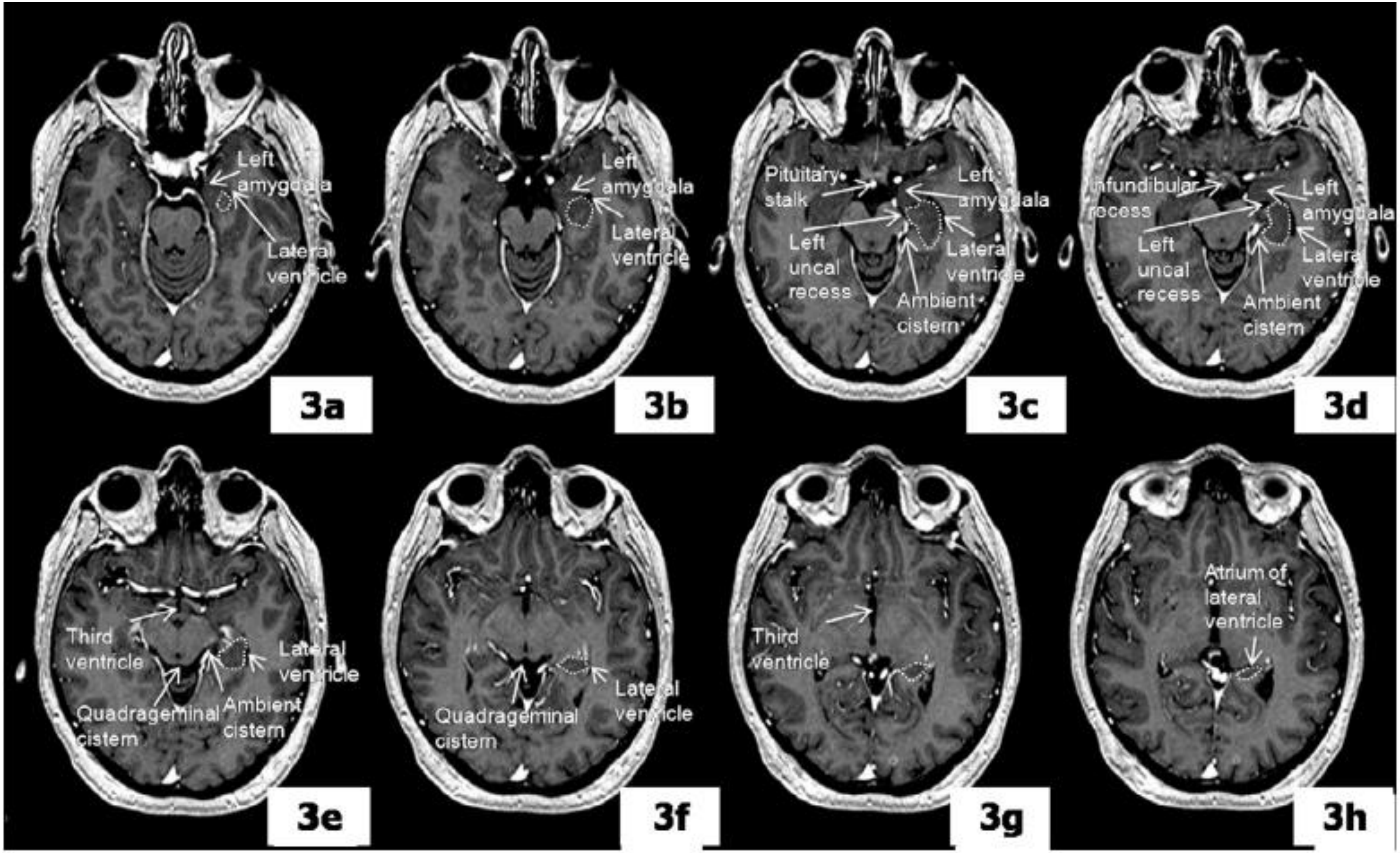


Pituitary gland

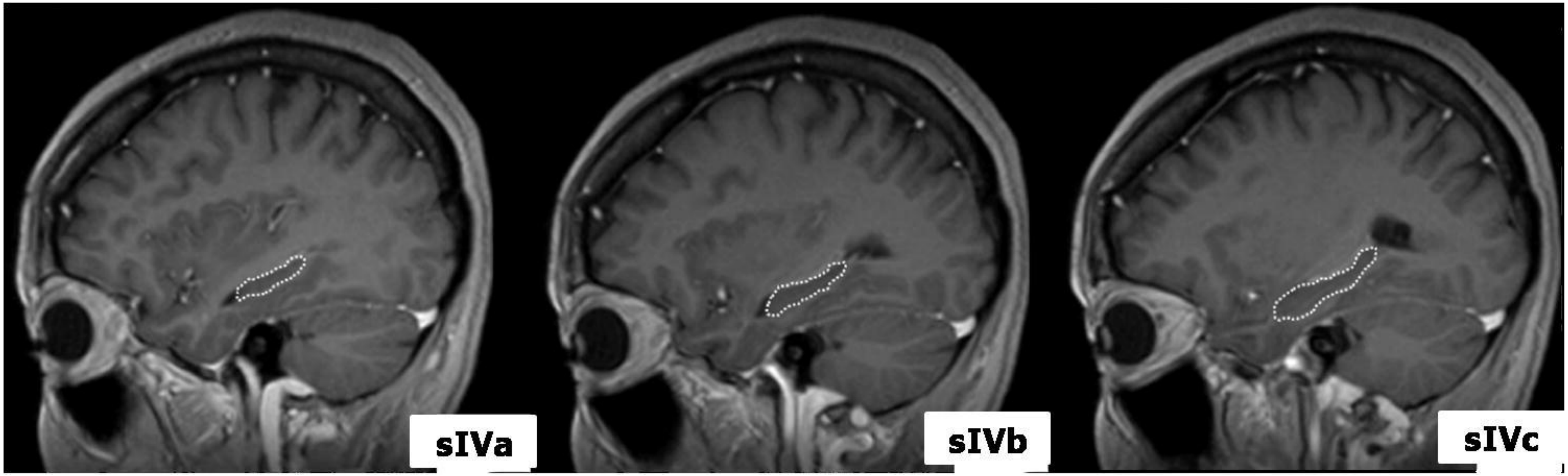


Retina & Lacrimal gland





Hippocampus



Hippocampus

ESTRO-ACROP guidelines: Gliobastoma

ESTRO-ACROP guideline "target delineation of glioblastomas"

Maximilian Niyazi[a,*], Michael Brada[b], Anthony J. Chalmers[c], Stephanie E. Combs[d], Sara C. Erridge[e], Alba Fiorentino[f], Anca L. Grosu[g], Frank J. Lagerwaard[h], Giuseppe Minniti[i], René-Olivier Mirimanoff[j], Umberto Ricardi[k], Susan C. Short[l], Damien C. Weber[m,n], Claus Belka[a]

Radiotherapy and Oncology 118 (2016) 35–42

To ensure accurate re-positioning the patient's head should be immobilized using an individually adapted mask system. Thermoplastic systems are the most widely used and can be prepared at the same appointment as the planning CT scan. A flat position with the head in neutral is the most widely accepted practice as it is most comfortable for the patient. A CT scan should be obtained using 1–3 mm slice thickness from the vertex to the lower border of C3.

Ideally an MRI scan less than two weeks old should be used. In general, contrast-enhanced thin-slice (3 mm or less) T1-weighted and FLAIR sequences should be fused with the planning CT. The use of 1-mm isotropic MPRAGE images may improve delineation of grey and white matter and small anatomical structures (hippocampi, optic pathway), significantly reduce flow artifacts and provide more accurate CT/MRI co-registration; however it is less sensitive to enhancement as compared to SE or TSE T1-weighted sequences.

OAR	If contouring on MRI always double check on CT in case of misalignment
Brainstem	The foramen magnum to the point where the optic tract passes lateral to the midbrain (this upper limit is arbitrary but easy to define and ensures consistency). Again, for consistency, the quadrigeminal (tectal) plate should be included
Chiasm	Sits above and behind the anterior clinoids and runs backwards above the sella turcica. For consistency, the anterior and posterior 'limbs' should extend 5 mm to include the start of the optic nerves anteriorly and optic tracts posteriorly. The chiasm can sometimes only be seen on a single slice as it is about 3 mm thick in cranio-caudal direction. It is often easiest to identify in the coronal plane
Cochlea	Sit just anterior to the lateral aspect of the internal auditory canal. They are most easily identified on the CT bone windows as small caves in the bone measuring 4–6 mm. Contour on 3 slices otherwise too small for dose calculation algorithms
Eyes	The whole of the outside of the globe should be contoured to include sclera and cornea. The macula lies opposite the lens
Lacrimal glands	These can be difficult (sometimes impossible!) to see – but they lie on the superior and lateral aspect of the globe with the inferior border at the (axial) equator of the globe and wrap around superiorly about 30 degrees (i.e. face on – left eye from 1 to 3 o'clock and right eye 9 to 11 o'clock). They sit anterior to the (coronal) equator of the globe. Dose limits should not be used to compromise PTV dose
Lens	Usually easy to see on the CT scan. However as cataracts are easily treatable the dose limits should never compromise PTV dose
Optic nerves	From the back of the globe to the optic chiasm passing through the optic canal to enter the skull anterior and inferior to the anterior clinoid. To help identify the exact path through the orbit change to CT bone windows. Ensure they join up with optic chiasm. It may be useful to check the structure in the sagittal plane to ensure the outlined structure is not an extra-ocular muscle
Pituitary	Within the sella turcica with chiasm lying superior and anterior to the stalk. As hypopituitarism is easily treatable the dose limits should never compromise PTV dose

EPTN consensus

The EPTN consensus-based atlas for CT- and MR-based contouring in neuro-oncology

Daniëlle BP Eekers [a,b,*], Lieke in 't Ven [a], Erik Roelofs [a,c], Alida Postma [d], Claire Alapetite [e], Neil G. Burnet [f], Valentin Calugaru [g,h], Inge Compter [a], Ida E.M. Coremans [i,j], Morton Høyer [k], Maarten Lambrecht [l], Petra Witt Nyström [w,x], Alejandra Méndez Romero [j,m], Frank Paulsen [n], Ana Perpar [o], Dirk de Ruysscher [a,l], Laurette Renard [p], Beate Timmermann [y,z,aa], Pavel Vitek [q], Damien C. Weber [r], Hiske L. van der Weide [s], Gillian A. Whitfield [t,u], Ruud Wiggenraad [j,v], Esther G.C. Troost [ab,ac,ad,ae,af], on behalf of the taskforce "European Particle Therapy Network" of ESTRO

Radiotherapy and Oncology 128 (2018) 37–43

EPTN consensus

Radiation dose constraints for organs at risk in neuro-oncology; the European Particle Therapy Network consensus

Maarten Lambrecht [a,b,*], Daniëlle B.P. Eekers [c,d], Claire Alapetite [e], Neil G. Burnet [f], Valentin Calugaru [e,g], Ida E.M. Coremans [h,i], Piero Fossati [j], Morten Høyer [k], Johannes A. Langendijk [l], Alejandra Méndez Romero [i,m], Frank Paulsen [n], Ana Perpar [j], Laurette Renard [o], Dirk de Ruysscher [c,d], Beate Timmermann [p,q,r], Pavel Vitek [s], Damien C. Weber [t], Hiske L. van der Weide [l], Gillian A. Whitfield [u,v], Ruud Wiggenraad [w], Erik Roelofs [c], Petra Witt Nyström [x,k], Esther G.C. Troost [y,z,aa,ab,ac], on behalf of work package 1 of the taskforce "European Particle Therapy Network" of ESTRO

Radiotherapy and Oncology 128 (2018) 26–36

Selection of OARs

In order to avoid overlap with existing head and neck atlases, typical head and neck OARs, which were previously published, were excluded from this consensus atlas [4]. All OARs at present known to be relevant for radiation-induced toxicity in neuro-oncology were included, namely: brain, brainstem, cochlea, vestibulum & semicircular canals, cornea, lens, retina, lacrimal gland, optic nerve, chiasm, pituitary, hippocampus and skin. In case of paired organs, each organ separately (left and right), and the unity of the two were contoured.

For future development of NTCP models, three distinct parts for the brainstem were defined, and regarding cognition, the posterior cerebellum, a new OAR possibly involved was included, as was the separation of the hippocampus into anterior and posterior parts. For research purposes also the hypothalamus was included. Of note, no validated dose–response curve relationships have thus far been published for these separate parts of the brainstem, hippocampus and cerebellum.

Uniform nomenclature

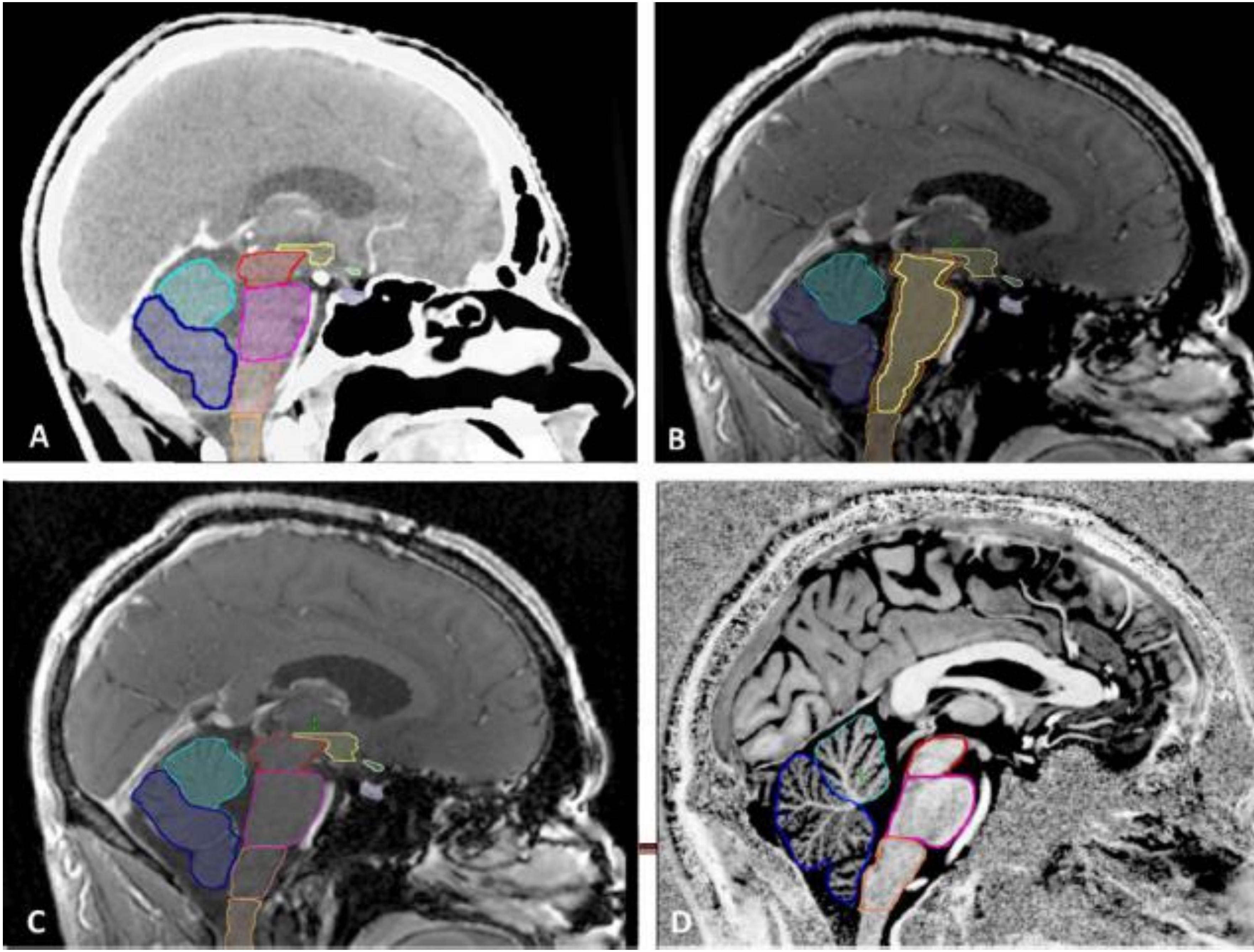
To facilitate future comparison of the structures, the proposed nomenclature is in accordance with work by Santanam et al. [9] on standardizing naming convention in radiation oncology, illustrated with quotes between brackets behind every structure name, for example: retina *("Retina_R", "Retina_L" and "Retinas")*.

Acquisition of CT and MR

CT images were acquired with intravenous contrast (Ultravist®, 150 ml of 300 mg Iodine per mL, 2 mL per sec, 5 min delay, slice thickness 1 mm, 50 cm field of view, 120 kV, 685 mAs) using window-width/window-level settings (WW/WL) of 120/40 and 120/1500 (SOMATOM Sensation 10, Siemens Healthcare, Erlangen, Germany) of the head of an adult male low grade glioma patient after first resection. Moreover, a three-dimensional spoiled gradient (3D-SPGR) axial 3T MR scan (1 mm slice thickness) of the same patient in standard axial, sagittal and coronal reconstruction, and an axial T2- and a gadolinium (Gadovist® 1.0 mmol/ml 0.1 mL/kg bodyweight) contrast-enhanced axial T1-weighted sequence were acquired, with sagittal and coronal reconstruction. Both CT and MR were obtained in the supine position with the head in a neutral position

15 OARs:

- Cornea
- Retina
- Lacrimal Gland
- Lens
- Optic Nerve
- Optic Chiasm
- Pituitary Gland
- Hypothalamus
- Hippocampus
- Cochlea
- Vestibular & Semicircular Canals
- Brain Stem
- Brain
- Cerebellum
- Skin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NRG PROTOCOL RADIATION THERAPY TEMPLATE

(Brain; Photon & Proton Therapy)

Last updated: 16 Jan 2019

Contiguous CT slices of 2.5mm - 3mm slice thickness or less should be obtained.

Standard Name	Description	Validation (Required/Required when applicable/Optional)
Brain	Whole brain parenchyma	Optional
BrainStem	Brainstem	Required
Cochlea_L	Left cochlea	Optional
Cochlea_R	Right cochlea	Optional
OpticChiasm	Chiasm	Required when applicable
OpticChiasm_PRV	Chiasm planning risk volume	Required when applicable
OpticNrv_L	Left optic nerve	Required when applicable
OpticNrv_R	Right optic nerve	Required when applicable
OpticNrv_PRV_L	Left optic nerve planning risk volume	Required when applicable
OpticNrv_PRV_R	Right optic nerve planning risk volume	Required when applicable
Hippocampus_L	Left hippocampus	Required when applicable
Hippocampus_R	Right hippocampus	Required when applicable
Hippocampus_PRV_L	Left hippocampus planning risk volume	Required when applicable
Hippocampus_PRV_R	Right hippocampus planning risk volume	Required when applicable
Eye_L	Left eye	Required
Eye_R	Right eye	Required
Lens_L	Left lens	Required when applicable
Lens_R	Right lens	Required when applicable
Retina_L	Left retina	Required when applicable
Retina_R	Right retina	Required when applicable
Glnd_Lacrimal_L	Left lacrimal gland	Required when applicable
Glnd_Lacrimal_R	Right lacrimal gland	Required when applicable

Standardizing Normal Tissue Contouring for Radiation Therapy Treatment Planning: An ASTRO Consensus Paper

Jean L. Wright MD [a], Sue S. Yom MD, PhD, MAS [b],
Musaddiq J. Awan MD [c], Samantha Dawes CMD [d,*],
Benjamin Fischer-Valuck MD [e], Randi Kudner MA [d],
Raymond Mailhot Vega MD, MPH [f], George Rodrigues MD, PhD [g]

Practical Radiation Oncology (2019) 9, 65-72

- **Concept paper.**
- **List of various OARs acc. to site listed in Appendices.**

Central Nervous System		
Treated Organ	**Recommended**	**Consider**
Brain	Brain Brainstem Eye_L/R Lens_L/R OpticChiasm OpticNrv_L/R SpinalCord	A_Carotid Cochlea Glnd_Lacrimal Hippocampus_L/R Pituitary Scalp
Craniospinal	Brain Brainstem Cochlea Esophagus Eye_L/R Heart Kidney_L/R Kidneys Lens_L/R Lung L/R Lungs OpticChiasm OpticNrv_L/R Pituitary SpinalCord	Bladder Bowel_Large Bowel_Small Breast_L/R Genitals Glnd_Thyroid Liver Ovary Rectum Stomach Testis_L/R

RINV-sparing RT

EFFECT OF BRAIN STEM AND DORSAL VAGUS COMPLEX DOSIMETRY ON NAUSEA AND VOMITING IN HEAD AND NECK INTENSITY-MODULATED RADIATION THERAPY

Katherine Ciura, B.A., R.T. (T), Michelle McBurney, B.S., R.T. (R)(T),
Baongoc Nguyen, A.S., Mary Pham, B.S., Neal Rebueno, CMD,
Clifton D. Fuller, M.D., Nandita Guha-Thakurta, M.D., and
David I. Rosenthal, M.D.

Medical Dosimetry, Vol. 36, No. 1, pp. 41-45, 2011

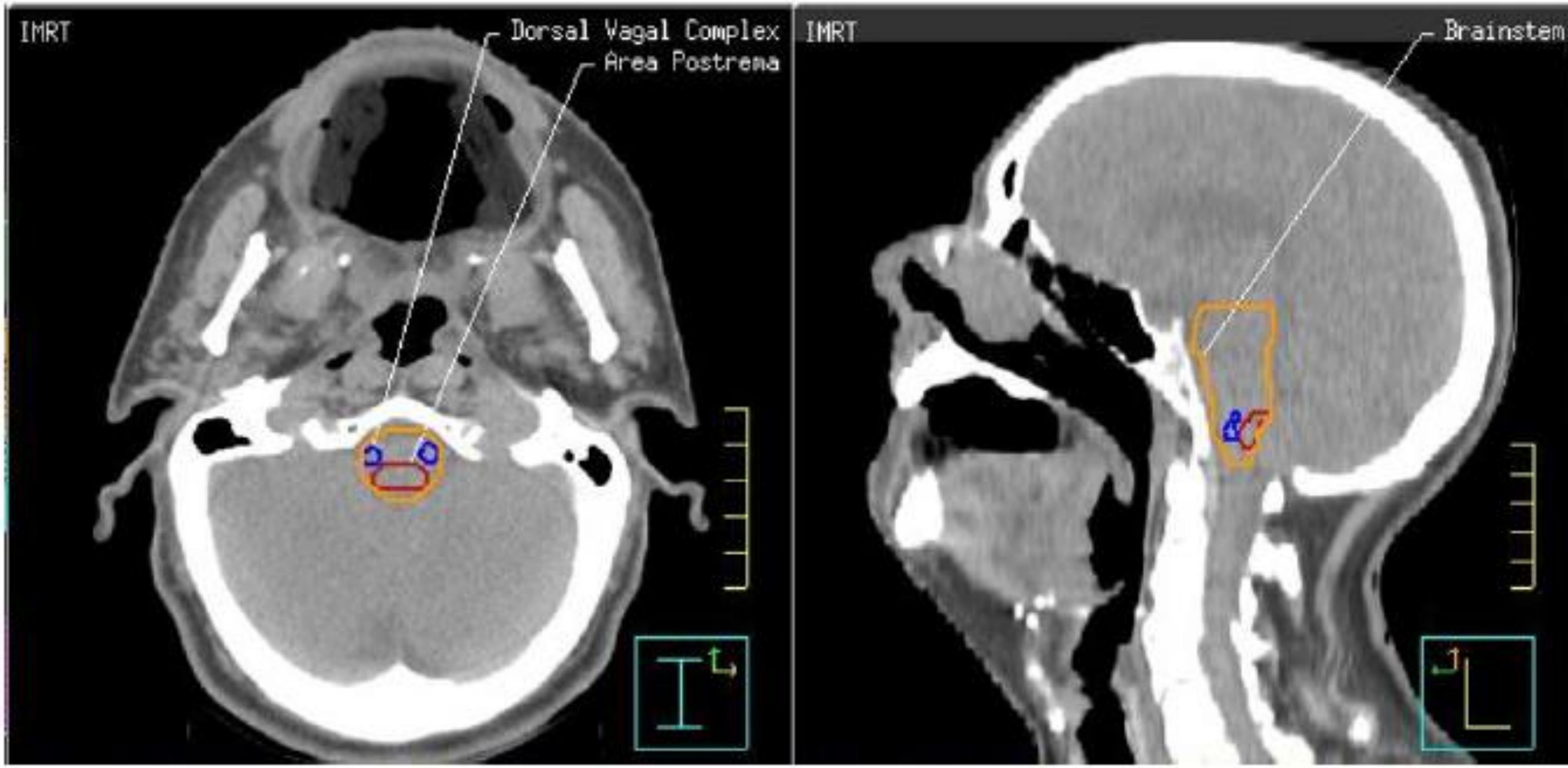


Fig. 2. Dorsal vagal complex, area postrema and brainstem delineation on CT.

Practical contouring guidelines with an MR-based atlas of brainstem structures involved in radiation-induced nausea and vomiting

Arnaud Beddok [a,g,*], Jean-Christophe Faivre [b], Alexandre Coutte [a], Jennifer Le Guévelou [c], Julien Welmant [d], Jean-Baptiste Clavier [e], Sébastien Guihard [e], Guillaume Janoray [f], Valentin Calugaru [g], Yoann Pointreau [h,i,j], Alexis Lacout [k], Julia Salleron [b], Michel Lefranc [l], Dominique Hasboun [m,n], Henri M. Duvernoy [o], Juliette Thariat [c,p]

Radiotherapy and Oncology 130 (2019) 113–120

MRI: **1.5T; 0.5mm slice thickness**

CT-RTP: **0.625mm slice thickness**

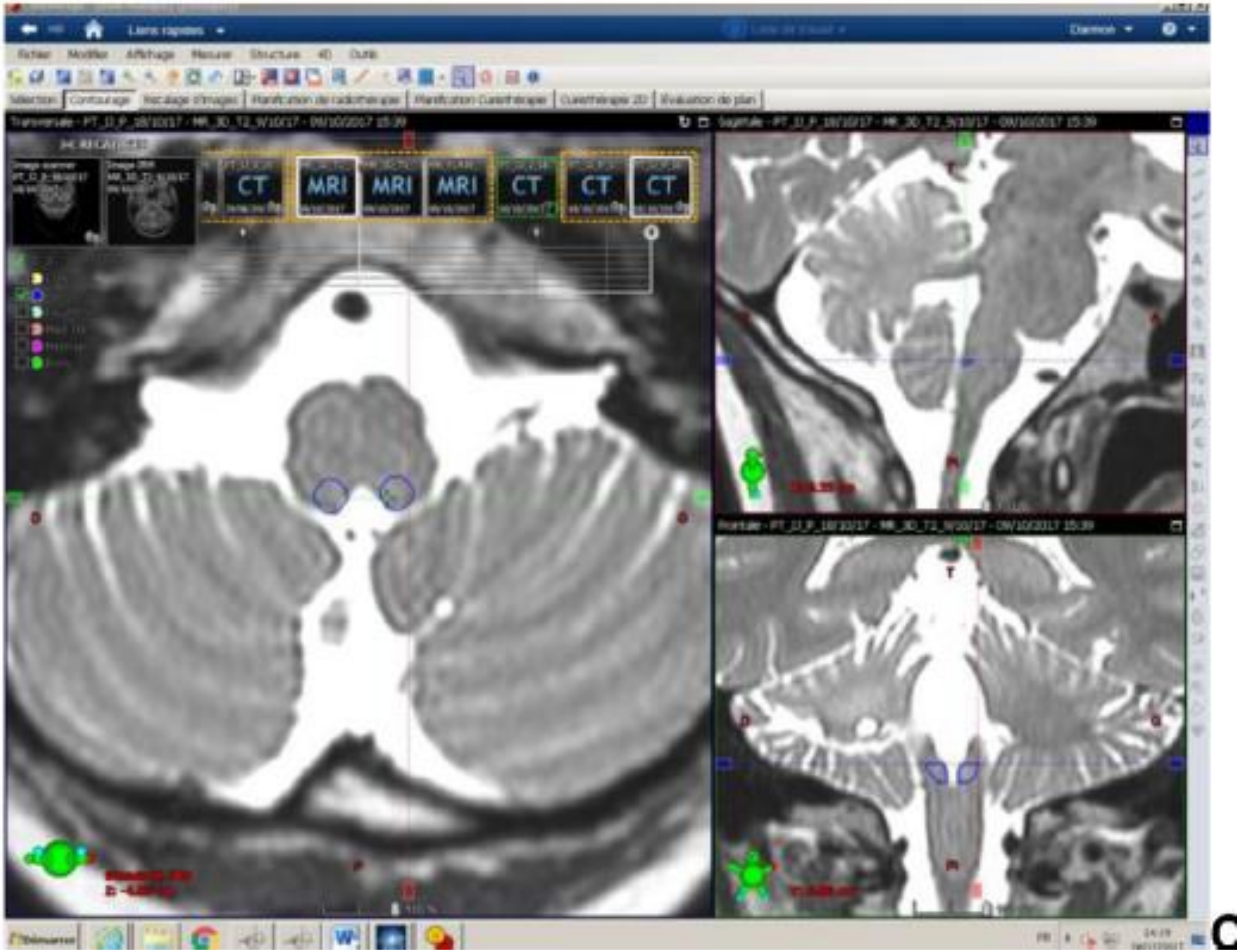
OARs considered:

- Midbrain
- Pons
- Medulla oblongata
- Dorsal Vagal Complex (DVC) – Area Postrema (AP) + Part of NTS (Nucleus Tractus Solitarius + DMV (Dorsal Motor Nucleus of Vagus)

Organs affected in RINV with specification of anatomic boundaries.

Borders per region	Brainstem			DVC (AP + NST + DMV)
	Medulla Oblongata	*Pons*	*Midbrain*	
Cranial	Caudal limit of the pons	Caudal limit of the cerebral aqueduct – Above the inferior coliculli of the midbrain. To include the superior cerebellar peduncles	Cranial limit of the cerebral aqueduct – up to an imaginary line at the level of the cranial border of the superior colliculi	5 mm cranial to the caudal limit of the DVC
Caudal	Foramen Magnum	Transversal plan of the pontomedullary sulcus	Cranial limit of the pons	Obex – central canal aperture (52 mm ± 3.5 mm distant of the line between the head and the body of the corpus callosum)
Anterior	Lateral cerebello-medullary cistern	Interpeduncular cistern	Interpeduncular cistern	A horizontal imaginary line at the level of the median sulcus
Posterior	Floor of the fourth ventricle Median aperture (foramen of Magendie) Posterior cerebello-medullary cistern	To include superior and inferior cerebellar peduncles Floor of the fourth ventricle	Quadrigeminal cistern	Ventral edge of the fourth ventricle (floor of the fourth ventricle)
Medial	Symmetric organ	Symmetric organ	Symmetric organ	Fourth ventricle
Lateral	Lateral aperture Lateral cerebello-medullary cistern	To include middle cerebellar peduncles	_	Use a circle of 4 mm in diameter

DVC: dorsal vagal complex. AP: area postrema. NST: nucleus of the solitary tract. DMV: dorsal motor nucleus of the vagus.



At the level of the DVC

Strongly recommend to pursue the ref./orig. articles!!!

THANK YOU!