Enhancing Setup Accuracy and Patient Comfort with Surface-Guided Radiotherapy: A Comparison of Open-Face Mask Immobilization and Head Adjuster versus Closed Masks

Sabrine Meftah, Phd

I.Nefzi,H.Jebali, N.Chaari, A.Kallel, L.Kochbati, M.Braiek, E.Saidi, A, Jebali,D.Chaabani, G,Ghribi, E.Neffouti, A.Dahmeni, A,Saidi, O.Abidi

Sabrine.meftah1@gmail.com

Introduction

Ennasr Clinic ,Tunisia

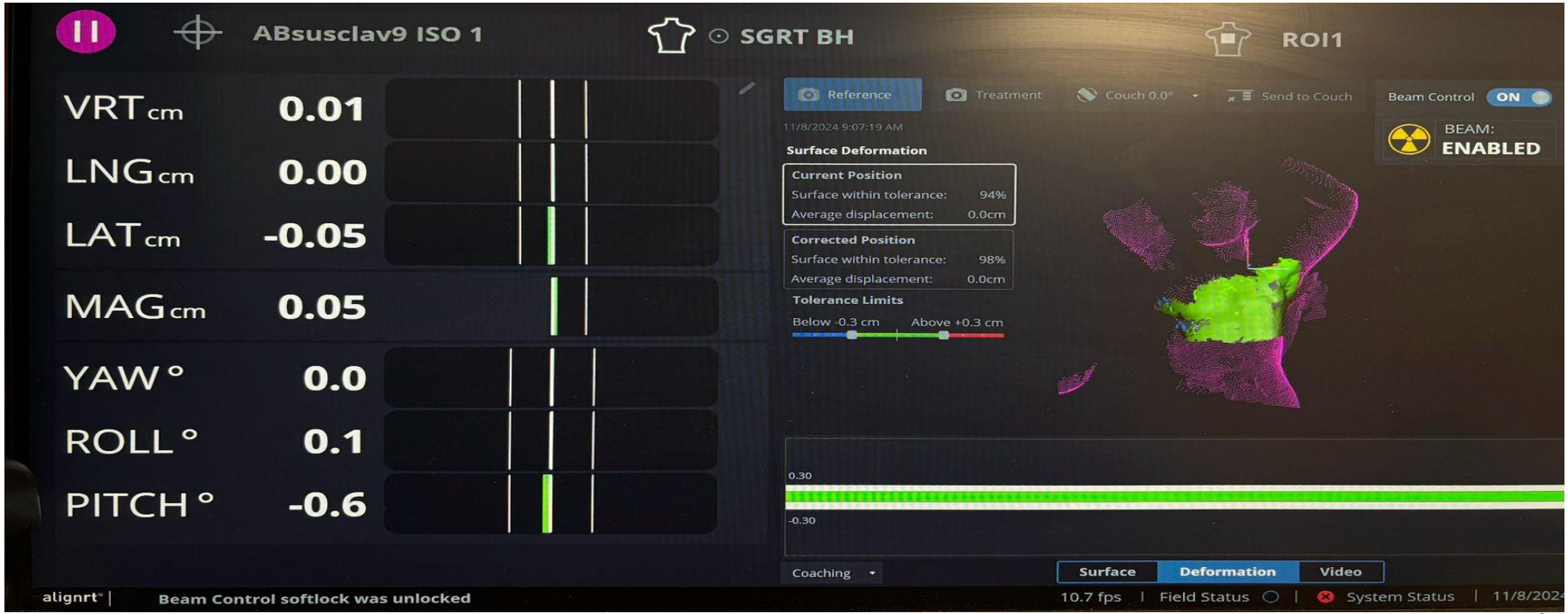
SGRT System: Align RT /Juanary 2024

Introduction

Breast cancer

Introduction

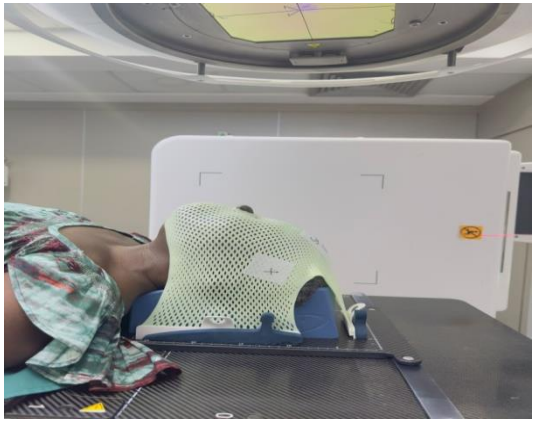
Left Breast cancer +++ DIBH

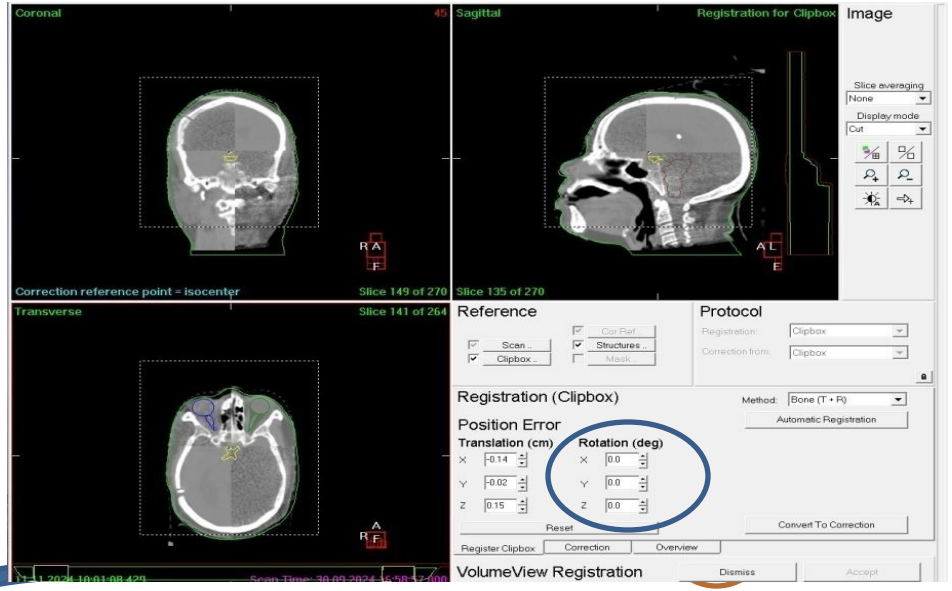


Introduction

SRS TTT Before SGRT:

- **Patient Set up**
  - Closed mask
- **Imaging Control**
  - KV+CBCT
  - No 6D Table (Accept small rotation)



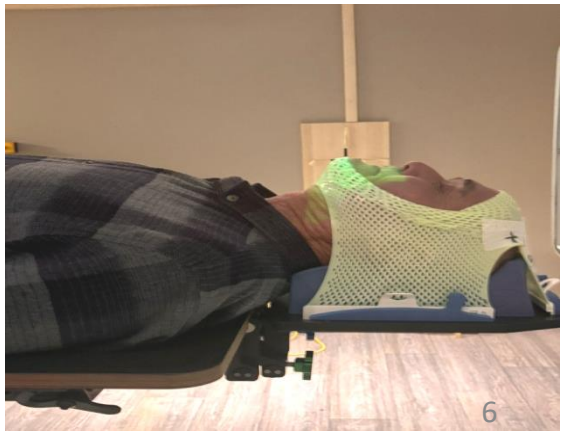


The impact of the accepted rotation on dosimetric constraints ??

Introduction

SRS TTT WITH SGRT:

- **Patient Set up**
  - Open mask
  - Head Adjuster
  - Align RT
- **Imaging Control**
  - KV+CBCT
- **TTT Monitoring**
  - Align RT



Problematic

Could the Head adjuster correct rotation errors and replace the 6D table for SRS TTT ?

Without 6D table or head adjuster what is the impact of the CBCT accepted rotation on dosimetric constraints ?

Without Align RT system what is the impact of an intrafraction variability on dosimetric constraints?

Can we change the image control routine and be satisfied with Align RT and KV images(Without CBCT) ?

In that case , What are the benefits of stopping using the CBCT in terms of Time and dose ?

Is there any Intrafraction variability difference between open mask and Closed mask ?

Purpose

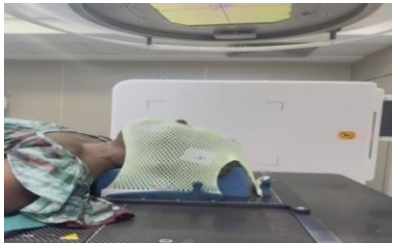
To assess the effectiveness of using Align RT system with an open-face mask immobilization and head adjuster in enhancing setup accuracy , dosimetric constraints and patient comfort

Method and material

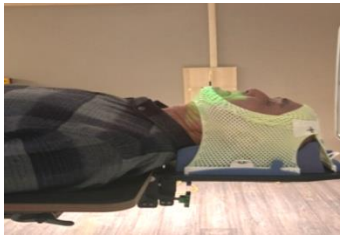
20 patients

10 Closed mask

10 Open mask+ Head adjuster



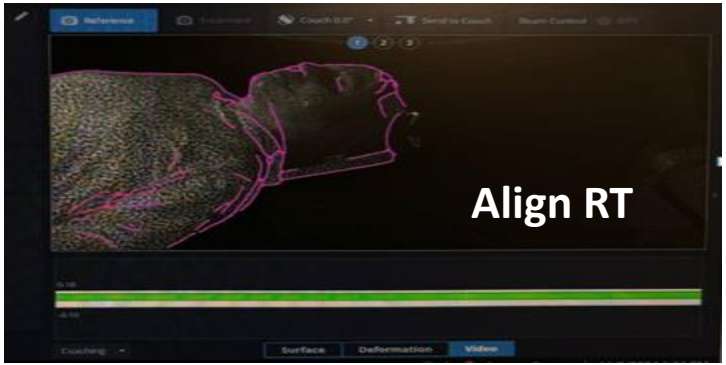
3 Points thermoplastic closed Masks « Klarity »

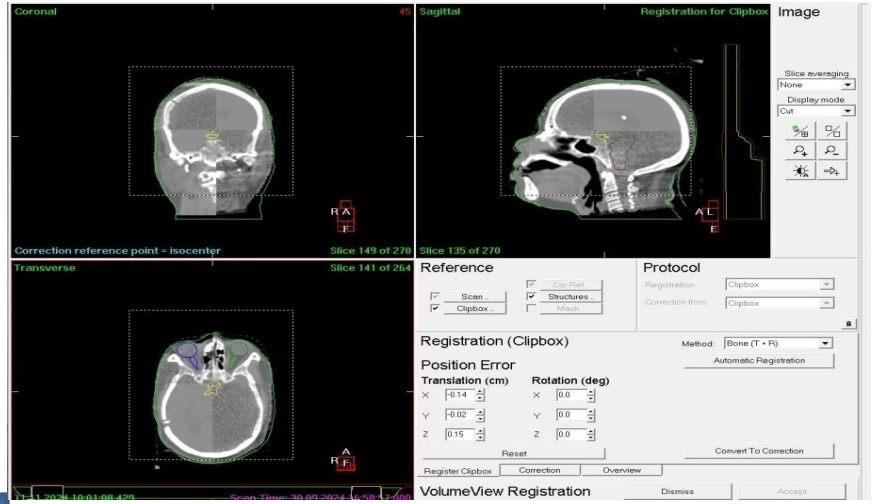


3 Points thermoplastic « klarity » open Masks (hand made)

Open Mask study

Positioning error Align RT/CBCT





Cbct Before the treatment

Evaluation of the agreement between the positioning errors from Align RT and the CBCT

Results: Open Mask

Positioning error Align RT/CBCT

The average positioning errors between Align RT and CBCT
0.4 mm, -0.5 mm, 0.5 mm
-0.20°, -0.1°, and 0.02°

Insignificant difference

The SGRT setup time : 0.35 min <<< CBCT setup time : 2 min

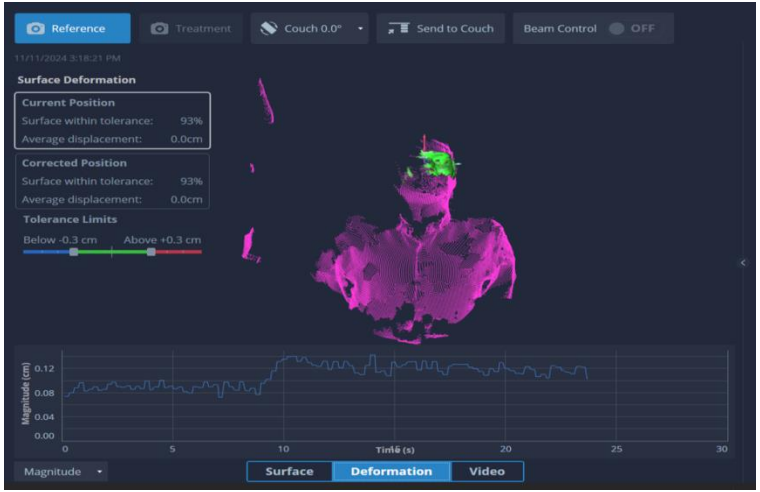
Open Mask study

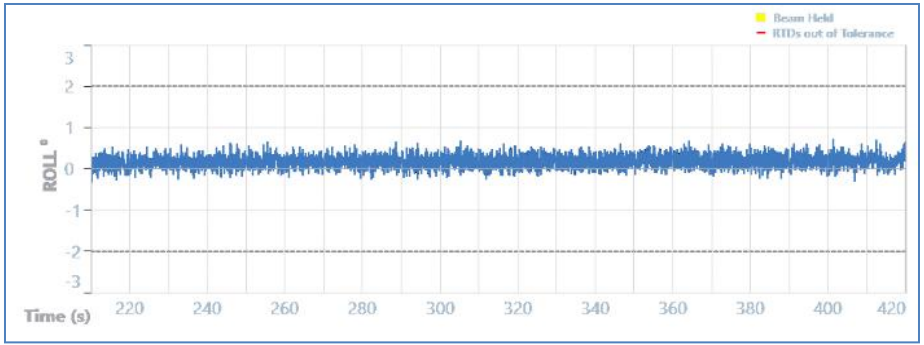
Intrafraction variability

Real time monitoring

Results: Open Mask

Intrafraction variability





Maximum variation : 0.6 mm and 0.5° in all directions

Real time monitoring

intrafraction variation is insignificant

NB: Our patients found open-face masks more comfortable, causing significantly less pressure on the face

DISCUSSION

RADIATION ONCOLOGY PHYSICS

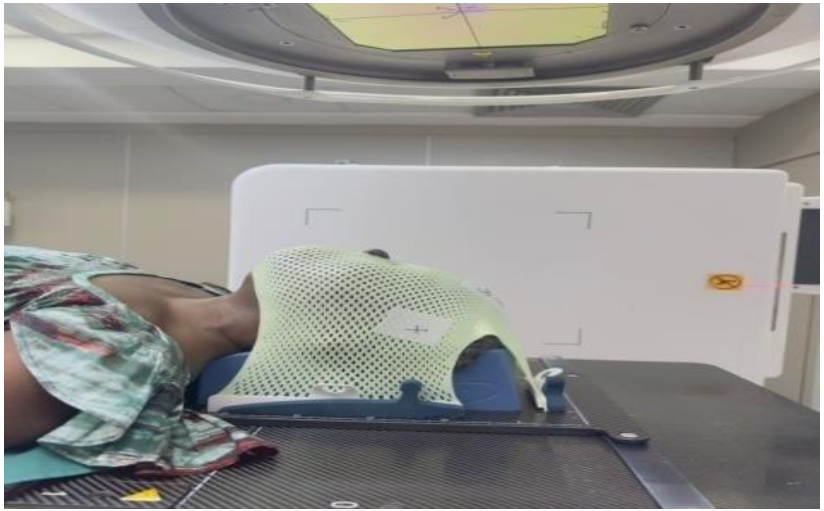
WILEY

Accuracy of surface-guided patient setup for conventional radiotherapy of brain and nasopharynx cancer

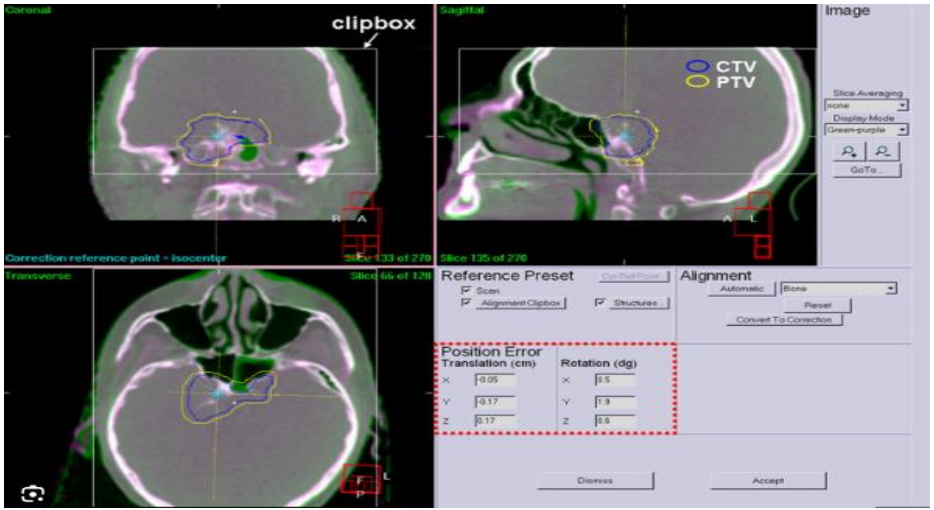
Sang Kyu Lee | Sheng Huang | Lei Zhang | Ase M. Ballangrud | Michalis Aristophanous | Laura I. Cervino Arriba | Guang Li

Closed Mask study

Intrafraction variability



3 Points thermoplastic closed Masks « Klarity »



Cbct after the treatment

Results: Closed Mask

Intrafraction variability

Cbct after the treatment

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	AVG
X (mm)	0.2	0.2	0.3	0.25	0.4	-0.5	0.25	0.4	0.2	-0.1	0,16
Y (mm)	-0.11	-0.04	0.2	0.3	0.4	-0.3	0.35	0.5	-0.35	-0.3	0,065
Z (mm)	0.07	0.06	0.08	0.6	0.3	0.08	0.07	0.06	-0.06	0.09	0,135

intrafraction variation is insignificant

DISCUSSION

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

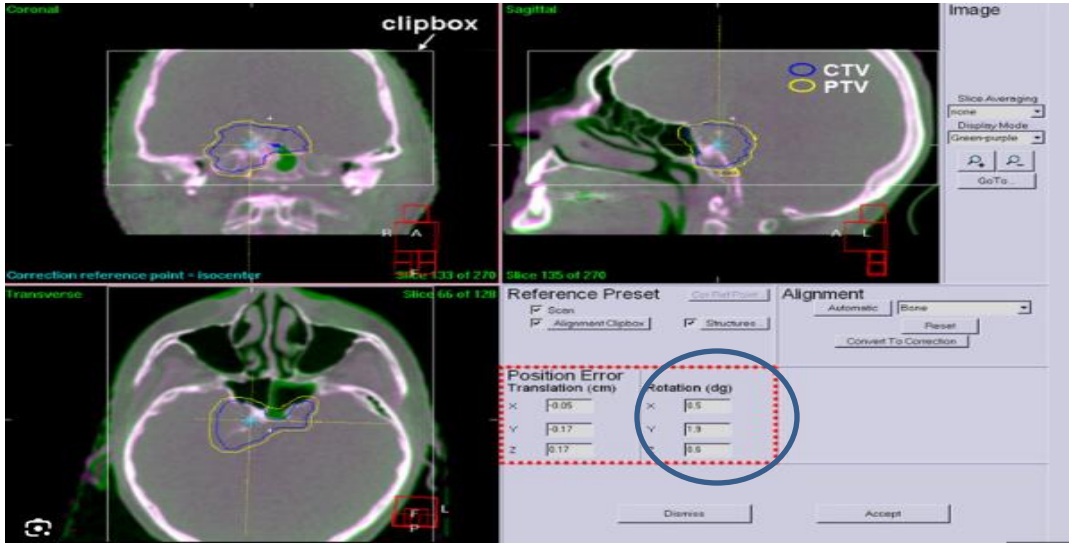
Original Article

Randomized self-controlled study comparing open-face vs. closed immobilization masks in fractionated cranial radiotherapy

Michèle Keane [3], Nienke Weitkamp [1,3], Indira Madani, Jonathan Day, Riccardo Dal Bello, Mariangela Zamburlini, Antonia Schiess, Amanda Moreira [2], Sophie Perryck, Katja Tomuschat, Marilyn Spencer, Stephanie Tanadini-Lang, Matthias Guckenberger, Michelle Brown *

Department of Radiation Oncology, University Hospital Zürich and University of Zürich, Rämistrasse 100, 8091, Zürich, Switzerland

Dosimetric impact of head rotation



Without 6D table:
Small CBCT rotation

Without real time monitoring :
How can we predict head rotation during the treatment ?

Results: Accepted rotation CBCT

CBCT before the TTT

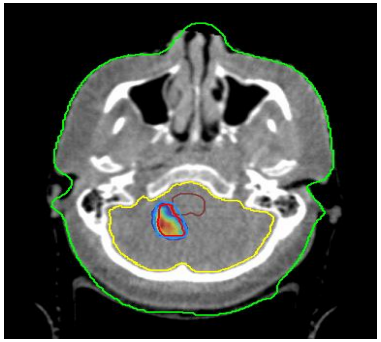
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	AVG
X'(°)	1	1,6	0,7	1,8	1,2	1,3	1	0,8	358,1	357,4	1
Y'(°)	0,8	0,1	358,9	359,7	0,8	1,7	1,6	359,3	0,5	0,5	0.8
Z'(°)	0,9	359,8	357,8	0,4	0,9	0,3	0,8	0,9	359,1	357,5	1

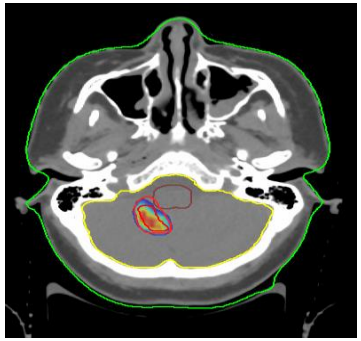
How can we evaluate the impact of this rotation on dosimetric constraints ?

Method and material: Dosimetric impact of head rotation

10 Patients
SRS / 30Gy 6Gy*5
PTV close To Organ at risk

1. • CBCT exported to MONACO
2. • Fusion CT /CBCT
   • Rigid adapt Anatomy
   • Recalculate the plan on the CBCT
3. • Comparison between the initial CT and the CBCT (++ BS, PTV)

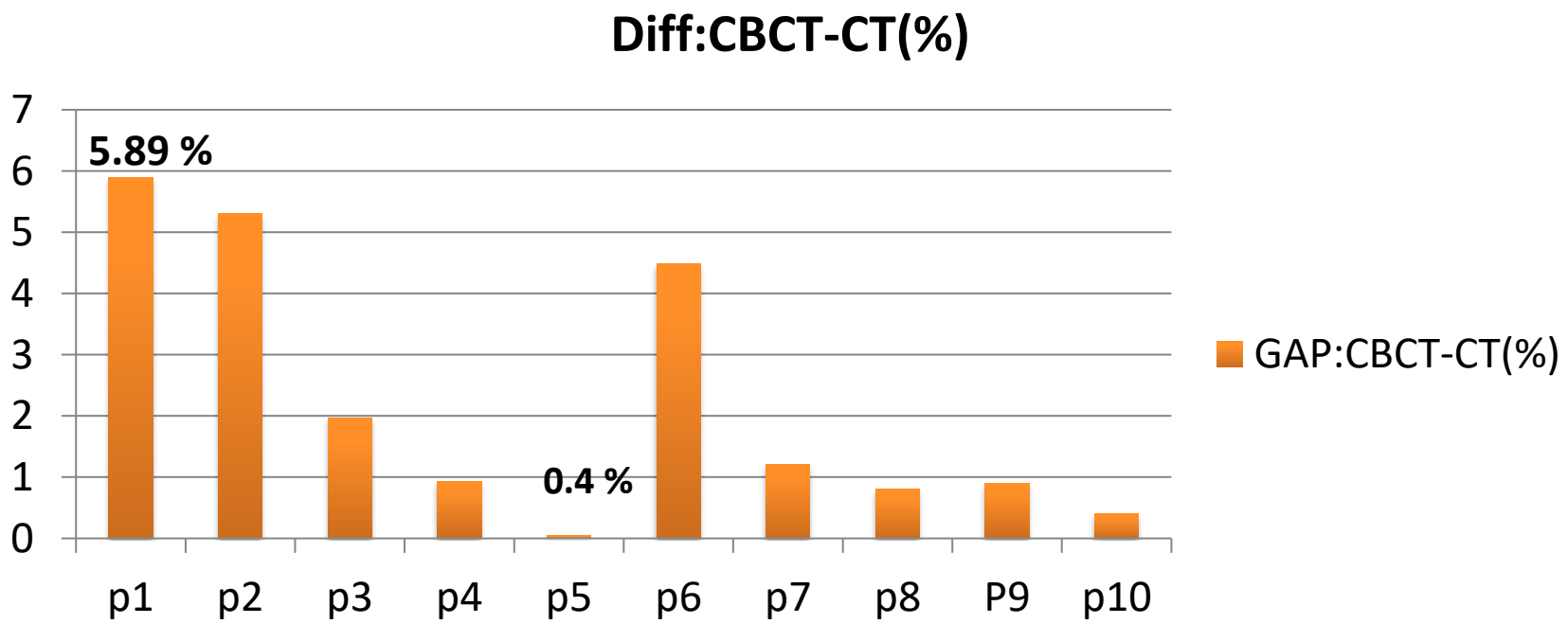




Monaco 6.1
Monte Carlo
Statistical uncertainties 1%
1 st method: CBCT Calibration Curve
Second Method: Patient forced to water

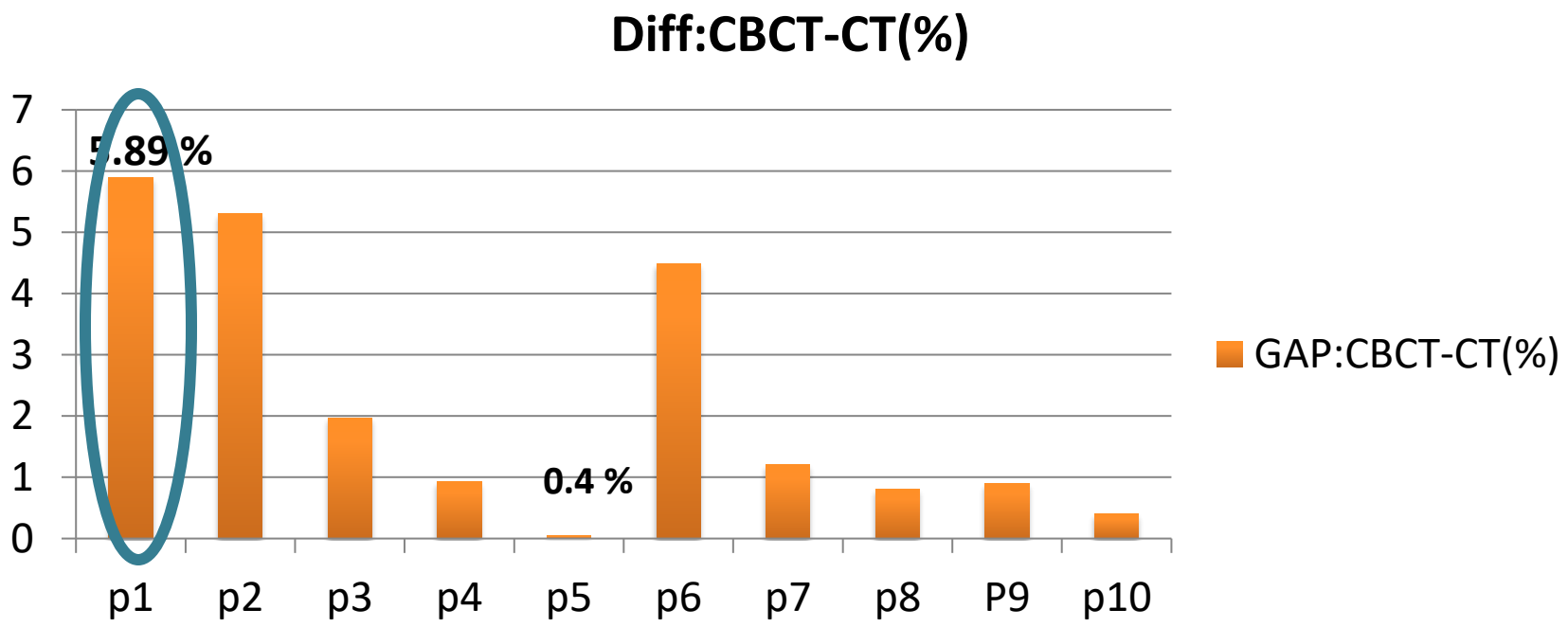
Results: Dosimetric impact of head rotation

PTV COVERAGE



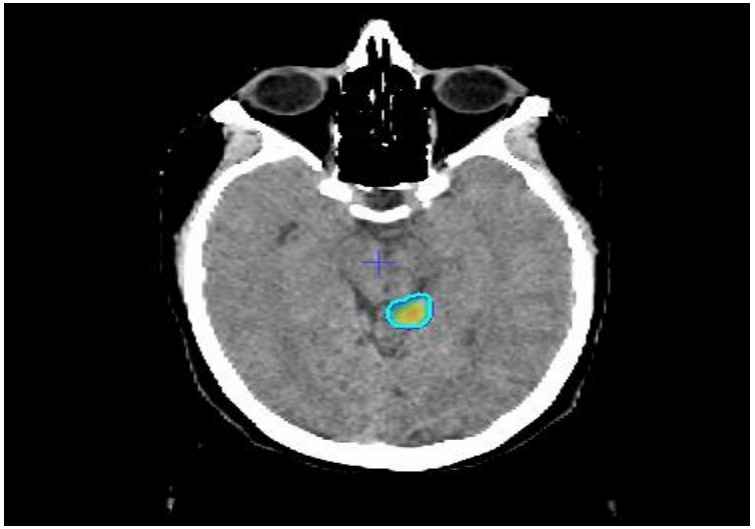
Results: Dosimetric impact of head rotation

PTV COVERAGE

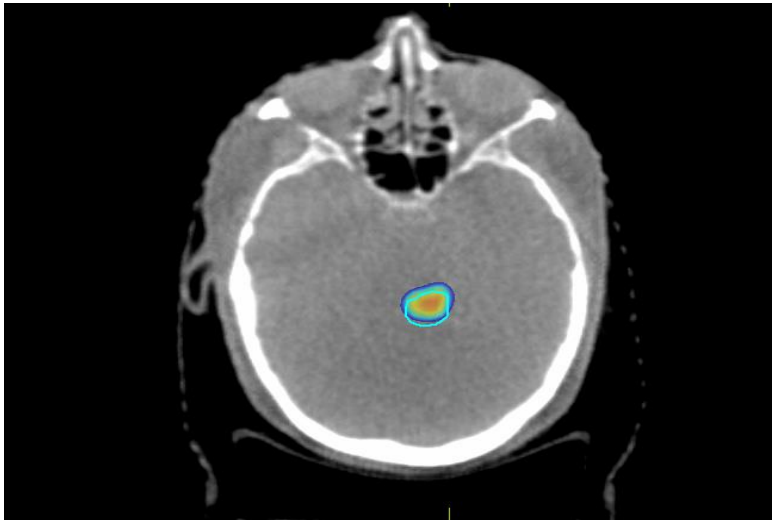


Results: Dosimetric impact of head rotation

PTV COVERAGE



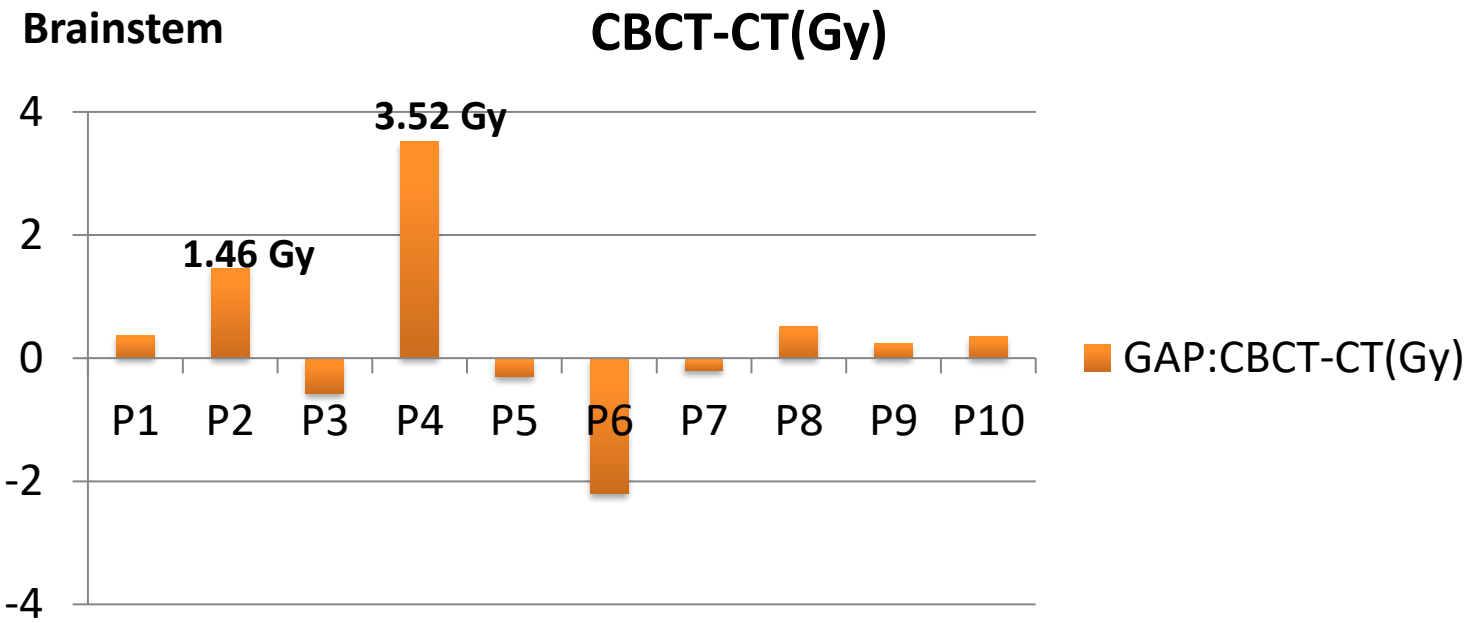
CT: D100%=99.6%



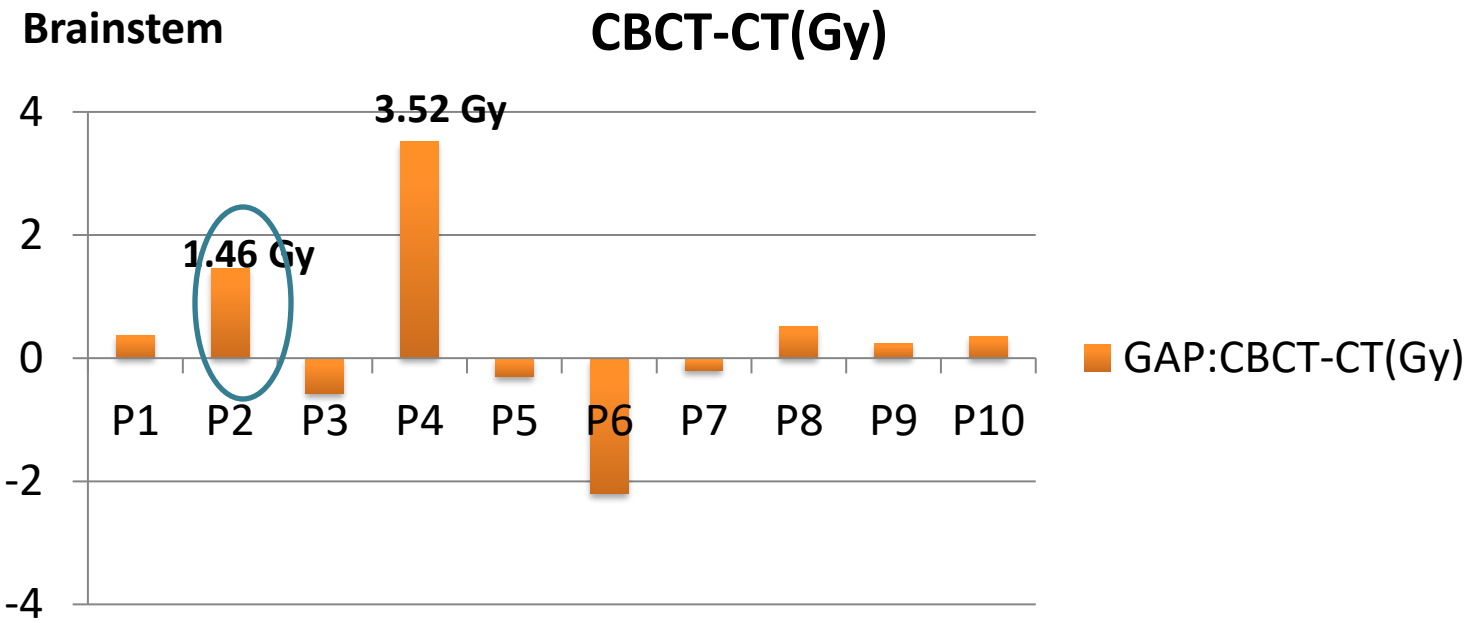
CBCT: D100%=93.7%

Under dosage of PTV

Results: Dosimetric impact of head rotation

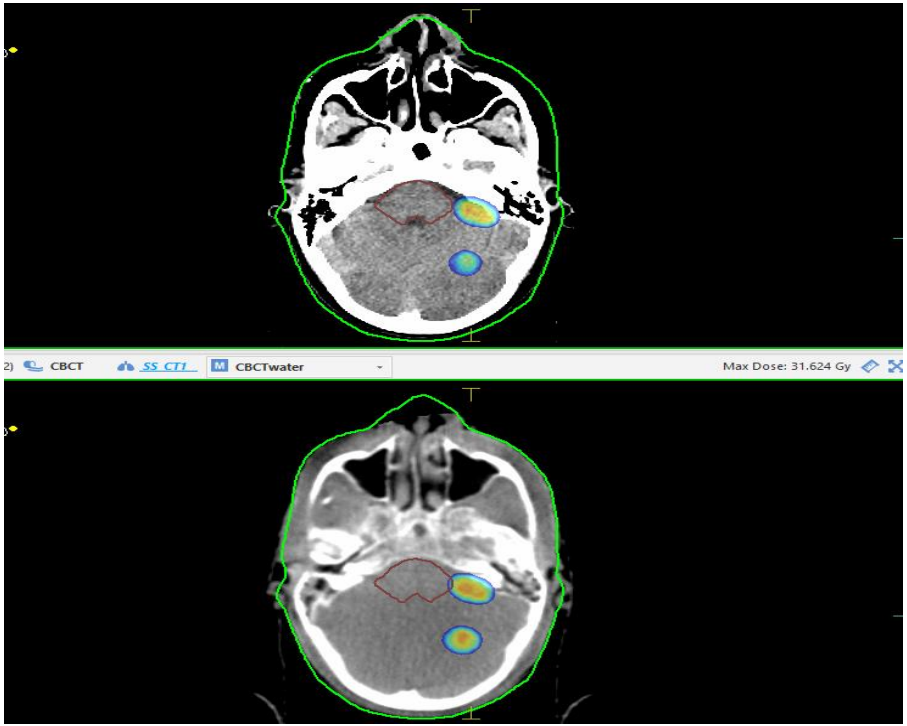


Results: Dosimetric impact of head rotation

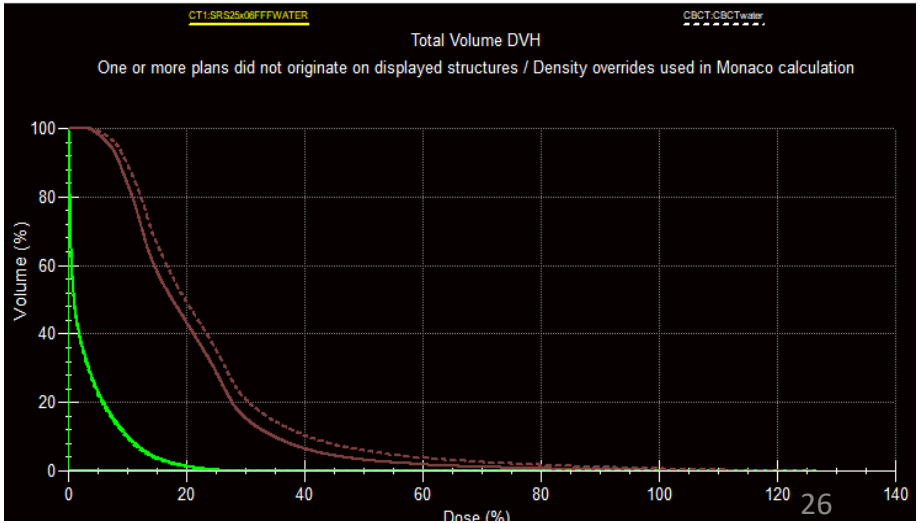


Results: Dosimetric impact of head rotation

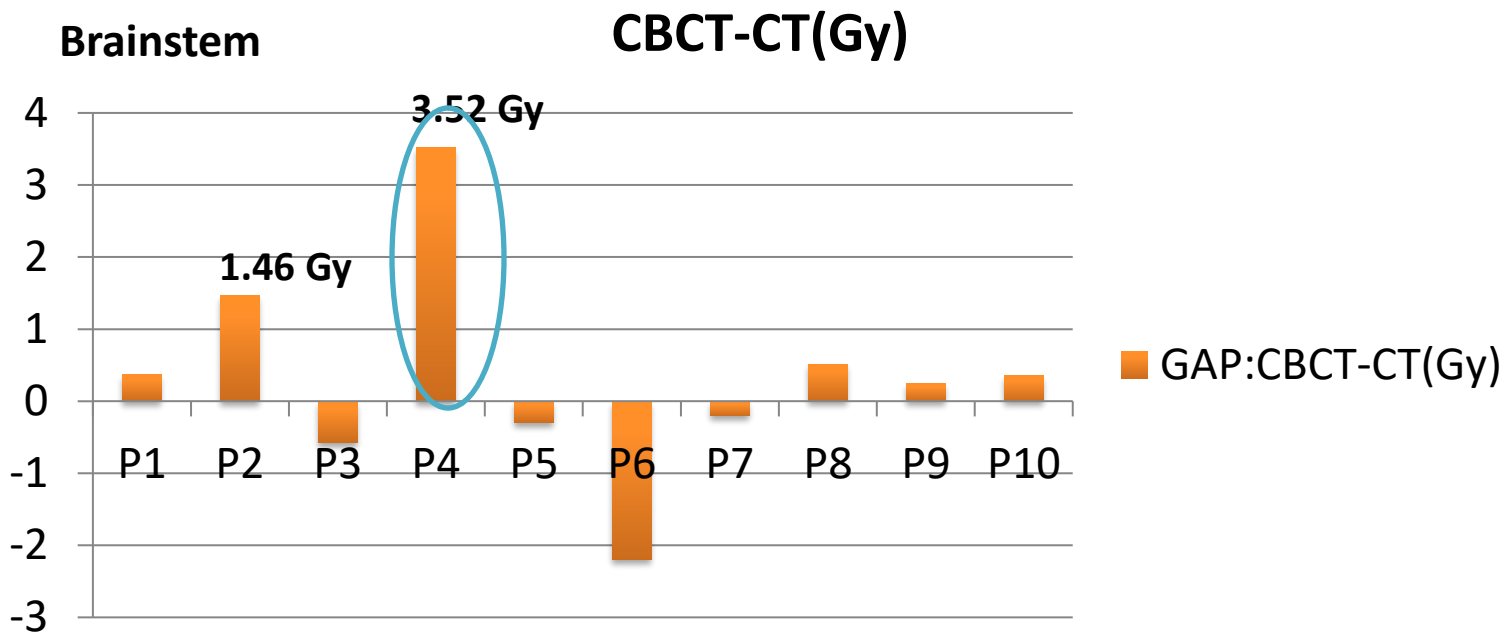
Brainstem



TRONC CEREBRAL	27.914	SRS25x06FFF...	CT1	0.598	28.707
TRONC CEREBRAL	27.914	CBCTwater	CBCT	0.647	30.169



Results: Dosimetric impact of head rotation



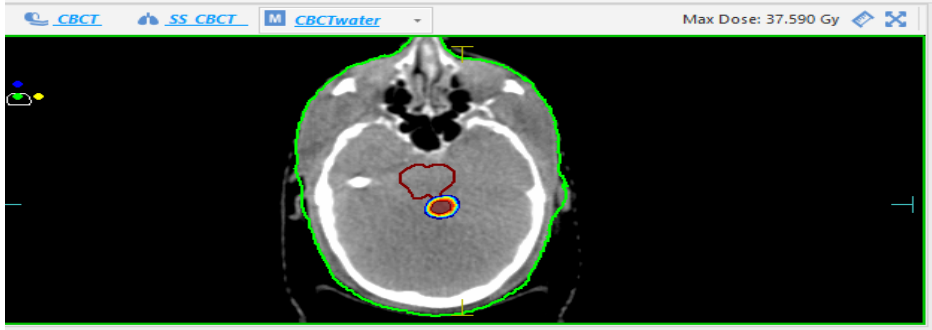
Results: Dosimetric impact of head rotation

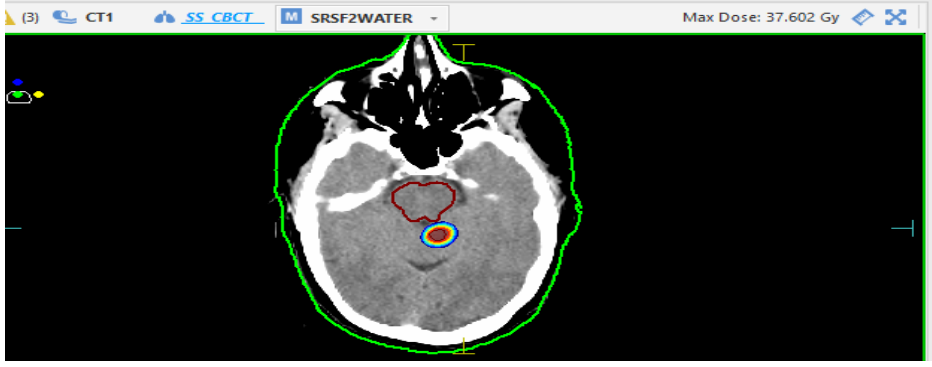
CBCT Accepted rotation

	day1	day2	day3	day4	day5	Average
X(°)	1.2	1.2	0	1	0.4	0.76
Y(°)	0.1	0.1	0.9	2	1.7	0.96
z(°)	0.5	0.5	0	1.1	0.5	0.52

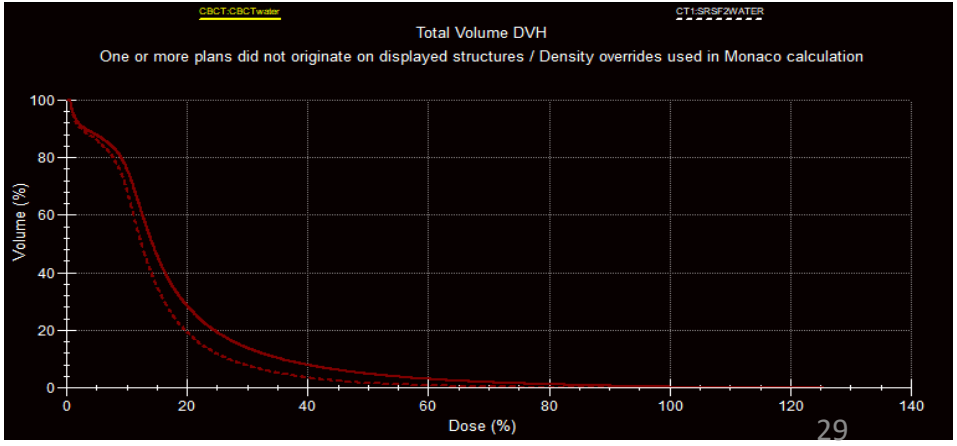
Results: Dosimetric impact of head rotation

Brainstem





BrainStem	21.810	SRSF2WATER	CT1	0.171	32.012	5.047
BrainStem	21.810	CBCTwater	CBCT	0.168	35.529	6.300



DISCUSSION

Disponible en ligne sur ScienceDirect www.sciencedirect.com
Elsevier Masson France EM|consulte www.em-consulte.com
Cancer Radiothérapie

Clinical practice guidelines

Organs at risk radiation dose constraints

Doses limites de radiations dans les organes à risque

G. Noël *, D. Antoni

Département de radiothérapie-oncologie, Institut de cancérologie Strasbourg Europe (ICANS), 17, rue Albert-Calmette, BP 23025, 67033 Strasbourg, France

Table 7
Dose constraints for ablative hypofractionated radiotherapy (dose per fraction > 6 Gy) schedules for organs at risk located in the skull and base of the skull.

Organ	Number of fractions					
	1	2	3	4	5	≥ 8
Brain	$V_{10\ Gy}$ < 10 mL [172] $V_{12\ Gy}$ < 5–10% [173] $V_{12\ Gy}$ < 7.9–8.5 mL [173] $V_{12\ Gy} \leq$ 5 mL [174,175]		$V_{20\ Gy} \leq$ 20 mL [174,175] $V_{23.1\ Gy}$ < 7 mL [176]		$V_{24\ Gy} \leq$ 20 mL [174,175] $V_{28.8\ Gy}$ < 3–7 mL [177]	
Optic tracts	Dmax < 8 Gy [178,179] Dmax < 10–12 Gy [172] Dmax > 12 Gy [174,180] $V8_{\ Gy}$ < 0.2 mL [178]	Dmax < 13.7 Gy [178] $V_{11.7\ Gy}$ < 0.2 mL [178]	Dmax < 10.5 Gy [176] Dmax < 17.4 Gy [178] Dmax < 20 Gy [174,180] $V_{15.3\ Gy}$ < 0.2 mL [178]	Dmax < 21.2 Gy [178] $V_{19.2\ Gy}$ < 0.2 mL [178]	Dmax < 25 Gy [178] Dmax < 15 Gy [177] Dmax < 25 Gy [174,180] $V_{23\ Gy}$ < 0.2 mL [178]	Dmax < 29.6 Gy [178] $V_{27.2\ Gy}$ < 0.2 mL [178]
Cochlea	Dmax < 6 Gy [172] Dmax < 9 Gy [178]	Dmax < 11.7 Gy [178]	Dmax < 14.4 Gy [178]	Dmax < 18 Gy [178]	Dmax < 22 Gy [178]	Dmax < 26.4 Gy [178]
Hippocampus	Dmax < 6.65 Gy [181] $V_{4.21\ Gy}$ < 100% [181]					
Brain stem	Dmax < 10–12 Gy [172] Dmax < 15 Gy [178,182] $V_{10\ Gy}$ < 0.5 mL [178]	Dmax < 19.1 Gy [178] $V_{13\ Gy}$ < 0.5 mL [178]	Dmax < 23.1 Gy [178] Dmax < 24 Gy [182] $V_{15.9\ Gy}$ < 0.5 mL [178]	Dmax < 27.2 Gy [178] $V_{20.8\ Gy}$ < 0.5 mL [178]	Dmax < 31 Gy [178] $V_{23\ Gy}$ < 0.5 mL [178] $V_{30\ Gy}$ < 5% [182]	Dmax < 37.6 Gy [178] $V_{27.2\ Gy}$ < 0.5 mL [178]
Spinal cord + medulla oblongata	Dmax < 10 Gy [182] Dmax < 12.4 Gy [182] Dmax < 13 Gy [182] Dmax < 14 Gy [178] [182,183] $V_{7\ Gy}$ < 1.2 mL [182,183] $V_{10\ Gy}$ < 0.35 mL [172,182,183] $V_{14\ Gy}$ < 0.035 mL [172,182] 6 mm on either side PTV $V_{10\ Gy}$ < 10% [182]	Dmax < 18.3 Gy [178] $V_{13\ Gy}$ < 0.35 mL [178]	Dmax < 20.3 Gy [182] Dmax < 21 Gy [182] Dmax < 22.5 Gy [178] $V_{15.9\ Gy}$ < 0.35 mL [178] 6 mm on either side PTV $V_{18\ Gy}$ < 10% [182]	Dmax < 25.6 Gy [178] $V_{18\ Gy}$ < 0.35 mL [178] 6 mm on either side PTV Dmax < 26 Gy [182]	Dmax < 25 Gy [182] Dmax < 25.3 Gy [182] Dmax < 25 Gy [178] $V_{22\ Gy}$ < 0.35 mL [178] 6 mm on either side PTV $V_{10\ Gy}$ < 10% [182]	Dmax < 33.6 Gy [178] $V_{26.4\ Gy}$ < 0.35 mL [178]

V_{xGy}: recipient volume *x* Gy; D_{max}: maximum dose.

Answers to Problematic…

Could the Head adjuster correct rotation errors and replace the 6D table for SRS TTT ?

Without 6D table or head adjuster what is the impact of the cbct accepted rotation on dosimetric constraints ?

Without Align RT system what is the impact of an intrafraction variability on dosimetric constraints?

Can we change the image control routine and be satisfied with Align RT and KV images(Without CBCT) ?

In that case , What are the benefits of stopping using the CBCT in terms of Time and dose ?

Is there any Intrafraction variability difference between open mask and Closed mask ?

Discussion and conclusion

Could the Head adjuster correct rotation errors and replace the 6D table for SRS processing ?

- **The Head adjuster perfectly corrects rotation errors and can replace the 6D table for SRS processing.**

Without 6D table or head adjuster what is the impact of the cbct accepted rotation on dosimetric constraints ?

Without Align RT system what is the impact of an intrafraction variability on dosimetric constraints?

- **A small head rotation (1°) can cause an overdosage at the OAR or underdosage at the PTV.**
- **The use of Align RT with a 6D table or a head adjuster is essential in the case of SRS treatment, especially in the case where the PTV is very close to the organs at risk.**

Discussion and conclusion

Can we change the image control routine and be satisfied with Align RT and KV images(Without CBCT) ?

The AlignRT system demonstrates excellent concordance with the CBCT gold standard
it is possible to change the image control routine and be satisfied with Align RT and KV images.

In that case , What are the benefits of stopping using the CBCT in terms of Time and dose ?

By eliminating CBCT controls:

- ✓ save time on the machine
- ✓ Less dose delivered to the patient

Discussion and conclusion

Is there any Intrafraction variability difference between open mask and Closed mask ?

- Intrafraction variability did not differ between open mask and Closed mask.
- Open-face masks are associated with decreased patient discomfort without compromising patient positioning and immobilisation accuracy.
- In this study we did not find an intrafrational variation with open and closed masks but if this is the case (lack of mask, etc.), it is important to follow any movements in real time during the treatment.

MESTRO
Middle East Society for Therapeutic Radiation Oncology

Clinique Ennasr

Thanks Team !

I.Nefzi
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