PATIENT SPECIFIC PLAN VERIFICATION OF A VMAT PLAN USING 3D POLYMER GEL DOSIMETER IN A PHANTOM REPRODUCING PATIENT ANATOMY

P. KARAISKOS,[1] G. KOLLIAS,[1] E. KOUTSOUVELI,[1] C. PARASKEVOPOULOU,[1] T. G. MARIS,[2] T. BOURSIANIS,[2] E. PAPPAS[3]

[1]*MEDICAL PHYSICS DEPARTMENT, HYGEIA HOSPITAL, ATHENS, GREECE*

[2]*MEDICAL PHYSICS DEPARTMENT, UNIVERSITY OF CRETE, HERAKLION, GREECE*

[3]*MEDICAL RADIOLOGIC TECHNOLOGY DEPARTMENT, TECHNOLOGICAL EDUCATIONAL INSTITUTE OF ATHENS, GREECE*

Purpose - Introduction

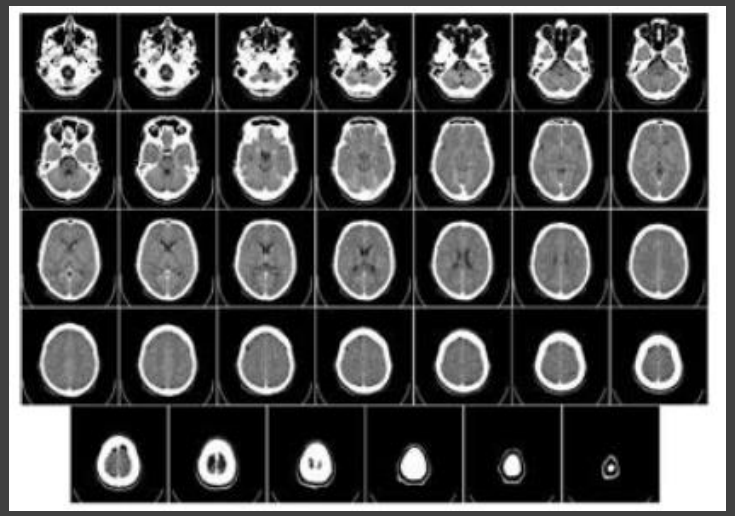
Stereotactic radiosurgery
- small target volumes
- high dose gradients
- need for minimal uncertainties in dose delivery

Dose verification in stereotactic radiosurgery
- Challenging due to the combined effect of steep dose gradients and loss of lateral electronic equilibrium.
- Development of end-to-end QA test employing 3D dosimetry

Scope :
- To use a patientspecific endtoend quality assurance approach, based on polymer gel dosimetry and patient-specific phantom created with 3-D printing technology, for plan verification and overall accuracy evaluation of a Volumetric Modulated Arc Therapy (VMAT) irradiation

Materials & Methods (I)

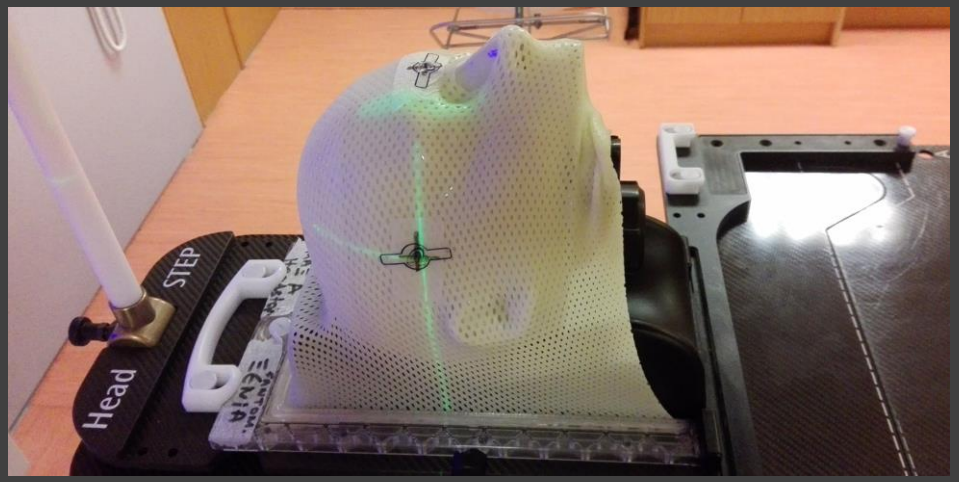
- Patient-specific phantom created with 3-D printing technology (RTsafe Co., Greece : www.rt-safe.com)
- Patient CT-scans were utilized as input to a 3D printer
- A 3D-hollow-phantom that duplicates the patient anatomy in terms of external surface and bone structures was constructed



Materials & Methods (II)

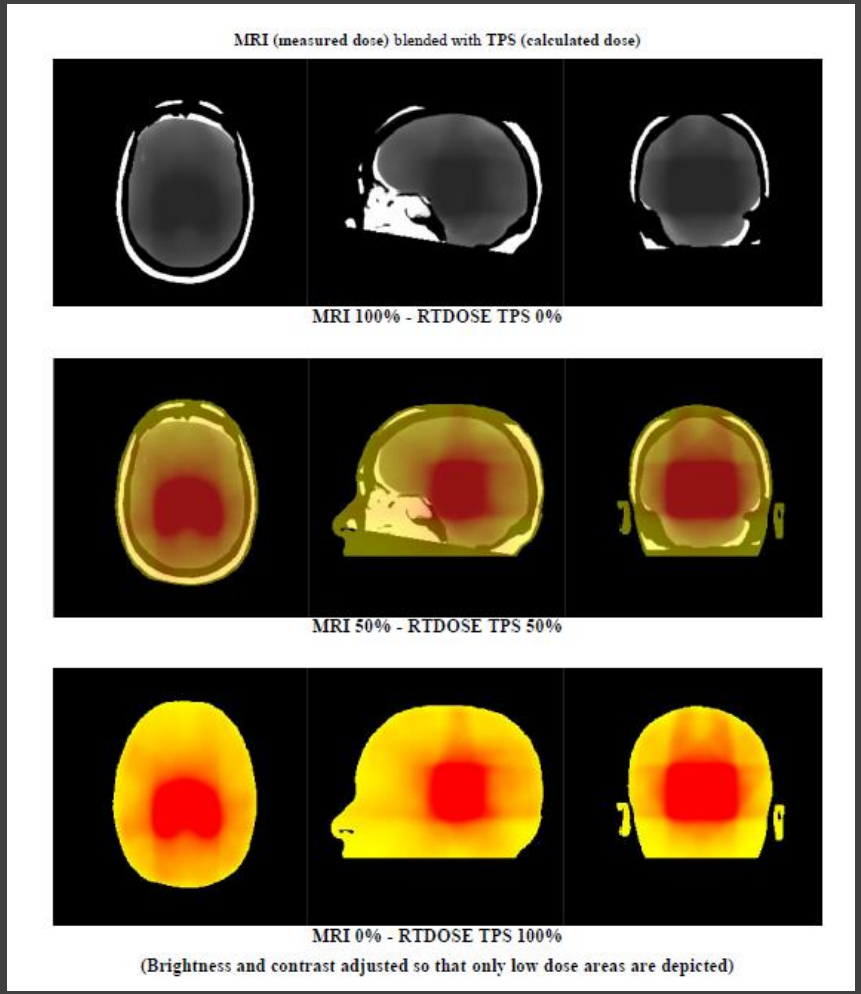
- The phantom was filled with a polymer-gel dosimeter and utilized to accurately reproduce every link in the treatment chain and irradiated using a 6 MV flattening filter free (fff) Elekta Versa linear accelerator.

- Upon irradiation, the phantom was MRI-scanned using a specially designed T2 pulse sequence and T2-maps were converted to 3D relative dose measurements.
- MR-images were coregistered to patient CTimages
- TPS dose calculations were compared with T2 measurements in an independent software



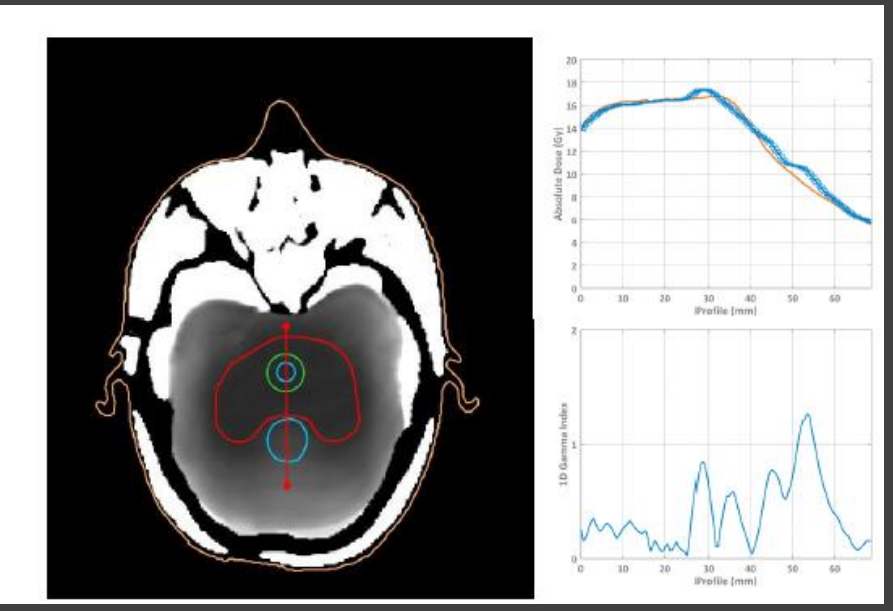
Results (I)

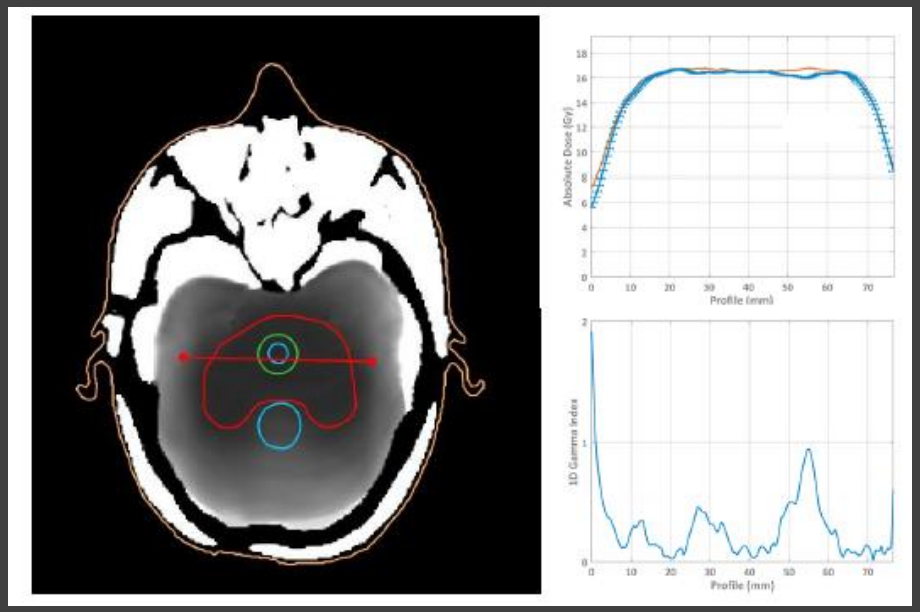
Radiation-
induced polymerization area was clearl
y evident in the T2-images and found to coincide to the high-dose target area in agreement with the TPS dose distribution.



Results (II)

Profiles comparison

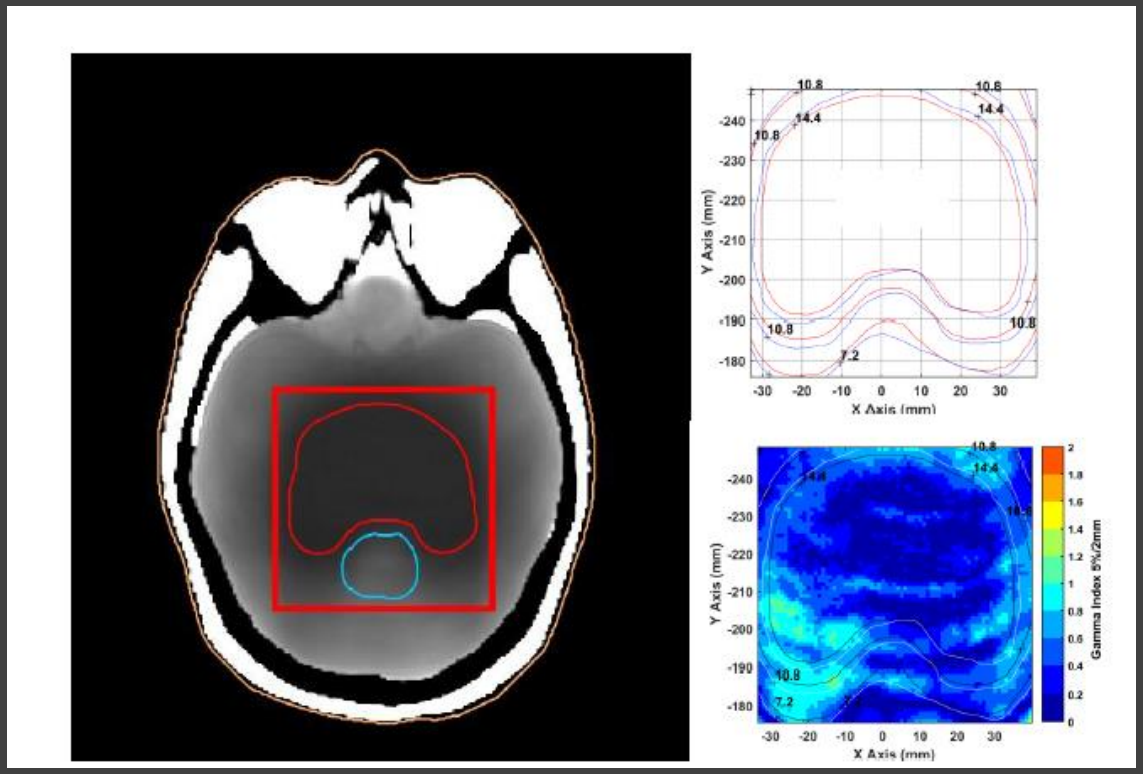




Relative dose profiles for both the measured (blue)and TPS-calculated (orange) datasets
1D gamma index calculations are also presented (passing criteria were 2 mm / 5%)

Results (III)

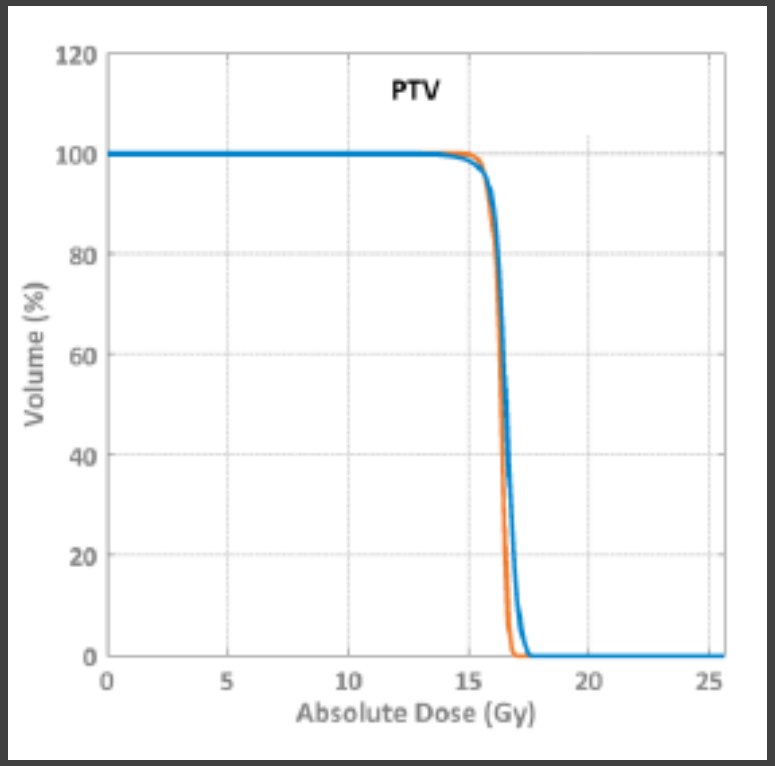
2D Gamma Index comparison

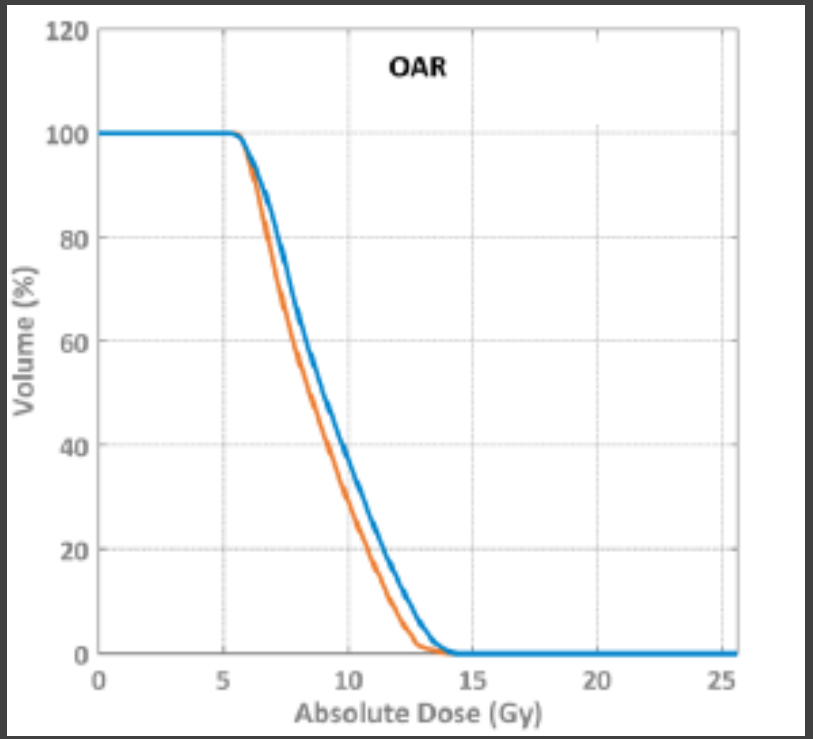


Dose distribution (measured: blue lines, TPS calculated: red lines) and gamma index comparison for the central axial plane. PTV and organ at risk (OAR) are also shown.

Results (IV)

DVH comparison





Comparison between TPS(red line) and measurements (blue line) in terms of cumulative Dose Volume Histograms (DVHs) for the target (PTV) and organ at risk (OAR)

Conclusions (I)

- 3D printing technology and water equivalent gel material allows the construction of a patient-specific phantom very similar to patient anatomy in terms of external contours and bone structures
- Capable of qualitatively evaluate dose delivery accuracy by comparing GammaPlan calculated dose distribution with radiation induced polymerization area
- 3D dosimeter with satisfied spatial resolution (< 1mm) capable of evaluated dose distributions using DVH criteria clinically used for plan evaluation and acceptance
- Commercially available: www.rtsafe.com

Conclusions (II)

The proposed methodology offers a unique way for 3Ddose verification including DVHs and could be supportive towards:

- patient specific plan verification
- end-to-end periodic QA
- confidence building processes in complex radiotherapy applications