24/25 OTTOBRE 2014
Università degli studi di Milano
STEREOTACTIC BODY RADIATION THERAPY
Implementazione, Sostenibilità, Avanzamento Tecnologico e Risultati a Confronto

Patient-specific quality assurance for Cyberknife treatments with radiochromic film

CENTRODIAGNOSTICOITALIANO CDI LIFE FROM INSIDE

M. Invernizzi, A. Bergantin, A.S. Martinotti, C. Vite, F. Ria, L.C. Bianchi, G. Beltramo
Centro Diagnostico Italiano, Milano

Introduction: The increased complexity of advanced radiotherapy techniques, such as Cyberknife stereotactic radiosurgery, requires a Quality Assurance (QA) program in order to verify the accuracy of the delivery of clinical doses. This study is finalized to implement in the clinical practice a pre-treatment QA method based on radiochromic film 2D dosimetry.

Materials and methods: A total of 60 treatment plans, with target volumes from 0.03 to 181 cc and planned maximum doses ranging from 6 to 21 Gy, is evaluated. The comparison between the delivered and calculated dose [Fig. 1] is based on the Gamma analysis method performed with an home-made MATLAB® code, using 4% local Dose Difference (DD) and 2 mm Distance To Agreement (DTA) criteria, and also reducing the DD to 3%.

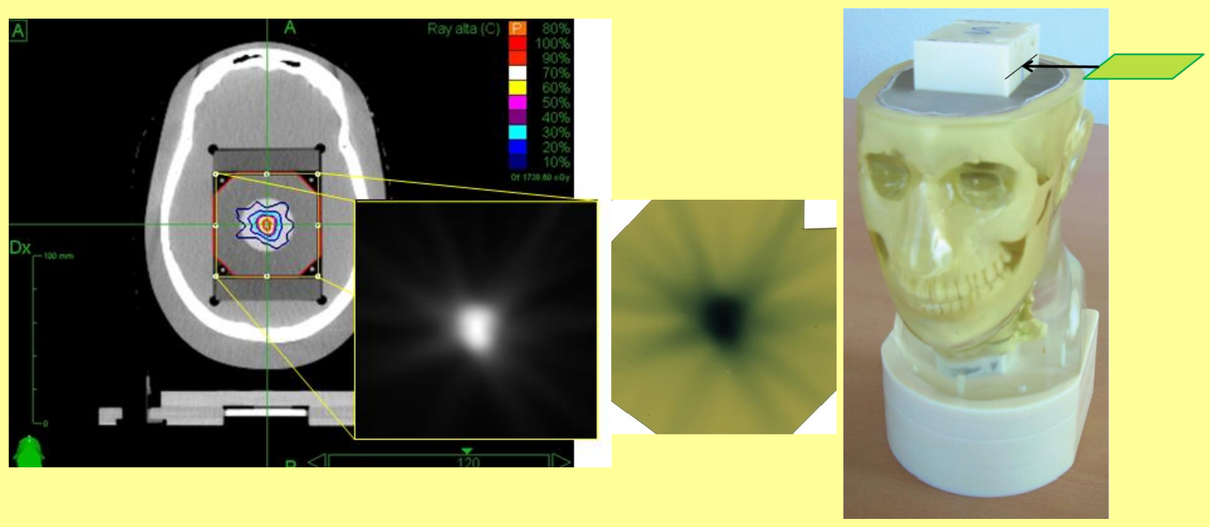

Fig 1

Red channel only Green channel only Mix RG channels

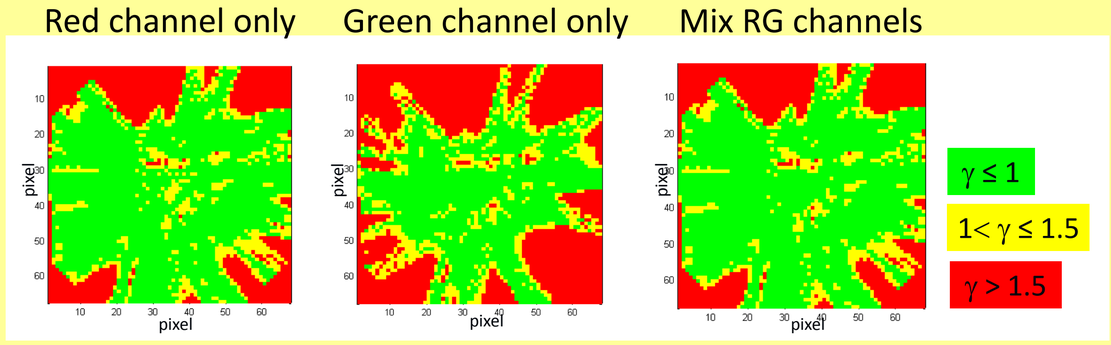

Fig 2

Gamma Analysis

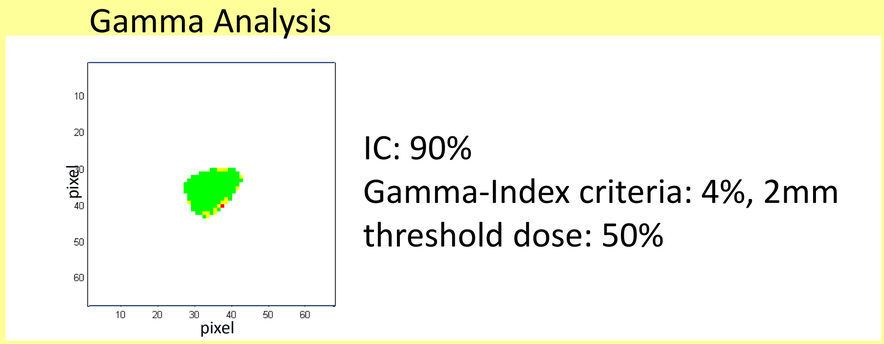

Fig 3

Results: The analyzed plans exhibit an overall average CI of 91%(10%) for a threshold dose of 50% and 89%(8%) for a threshold dose of 20%, with 4% and 2 mm criteria. Reducing DD to 3%, the analyzed plans show a CI of 87%(11%) for a threshold dose of 50% [Fig. 4].

The analysis is executed with a combination of the red and green channel response, considering the red channel for planned doses below 10 Gy and the green channel for doses above 10 Gy [Fig. 2]. Different threshold doses (TD: % of the planned maximum dose) are selected for the Confidence Index (CI) evaluation [Fig. 3].

CONFIDENCE INDEX		
	DD: 4% DTA: 2mm	DD: 3% DTA: 2mm
5% threshold	**83%** (13%)	**78%** (13%)
20% threshold	**89%** (8%)	**86%** (9%)
50% threshold	**91%** (10%)	**87%** (11%)

Fig 4

Conclusion: The method proposed has shown a good agreement between the planned and measured dose distributions, both within the high dose region nearer to the target (TD 50%) and in the low dose region that includes critical structures (TD 20%). The use of a double channel Gamma analysis has proven to be effective in increasing this accordance, taking advantage of the characteristic dose response of radiochromic EBT2 in the red and green channels. The next improvements of this QA include:

- the reduction of the Gamma-Index criteria, in particular DTA 1 mm, with an improvement in the registration of the images and with the use of a phantom that guarantees a more rigorous positioning of the film;
- the use of a dedicated software that provides both the Multichannel Film Dosimetry (Micke et al.), to further optimizes the response of radiochromic films, and the One Scan Protocol, to scan the film after only 15 minutes from the delivery.

§corresponding author: marta.invernizzi@cdi.it