

E2E testing based on alanine and IC dosimetry for a new combination of TCS/OIS & PBS proton gantry.

P. Roisl¹, M. Schafasand^{1,2}, J. Hopfgartner¹, M. Stock^{1,3}, A. Carlino¹

1 MedAustron Ion Therapy Center, Wiener Neustadt, Austria

2 Medical University of Vienna, Department of Radiation Oncology, Währinger Gürtel 18-20, 1090 Wien, Austria

3 Karl Landsteiner University of Health Sciences, Dr.-Karl-Dorrek-Straße 30, 3500 Krems and der Donau

Purpose

In this work we report the results of functional and dosimetric end-to-end test procedures for proton treatment plans created with the RayStation 11B SPC1 (RaySearch Laboratories, Sweden) TPS. The tests were based on customized phantoms and different dosimetric techniques performed with the cooperatively developed and integrated treatment control system RayCommand 2B SPC2 for the newly installed gantry of MedAustron (MA)².

Materials & Methods

Prior to the performed end-to-end tests extensive commissioning of the treatment machine model based on the Monte Carlo MC5.3 dose algorithm in RS11B SP1 was performed. End-to-end tests were administered in RayCare 5B SPC1 and all treatment plans finally executed in RayCommand.

CT scans of a homogeneous polystyrene and two anthropomorphic (pelvis and head (CIRS, Norfolk, VI, USA)) phantoms were taken in reproducible positions on the patient couch. For clinical workflow homogenous plans covering the area of measurement were created with RS11B SPC1. Before delivery, image guided patient positioning was performed using the clinical RayCommand treatment workflow. The absolute dose in the center of the dose distributions was measured with the PTW-TM30013 Farmer type chamber as well as 22 alanine pellets positioned across the dose distribution. Additionally GAFchromic films were placed within the phantoms for dose homogeneity evaluation. The alanine pellets and their read-out were provided by the National Physical Laboratory (NPL) in UK. Evaluation of the measurement results was performed according to Carlino et al, 2018¹.

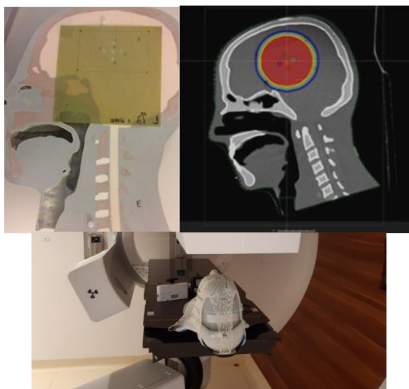


Figure 1. End-to-end test procedure with the head phantom. Top left: the loading of the phantom with alanine pellets and GAFchromic films. Top right: the treatment plan preparation in RayStation 11B SPC1. Bottom: the positioning and irradiation with actively scanned proton beams.

Results

The clinical workflow of RayCare as OIS and RayCommand as TCS allowed a smooth and intuitive preparation and delivery of the end-to-end test treatment plans. The measured absolute dose to water obtained with the Farmer chamber in four delivered plans, which included combinations of 0°, 90° and 150° gantry beams, was within 2% of the planned dose. Doses determined with the alanine pellets after correction for the quenching effect showed a mean deviation from the planned doses within 0.23% with a std. deviation of 0.8% and a maximum deviation below 2.5% for all the phantoms (figure 2).

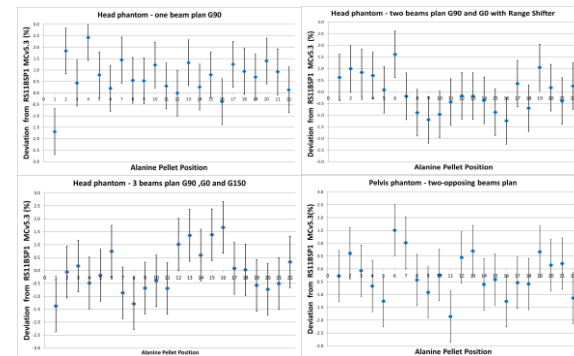


Figure 2. Relative deviations of alanine measurements from TPS calculated dose in 4 irradiated plans

Conclusion

The end-to-end test procedures showed that the MedAustron gantry in combination with the dedicated TPS, OIS and TPS provides the possibility to prepare and deliver treatment plans very close to a realistic patient workflow with high dosimetric precision and accuracy.

References

1. Carlino, Antonio & Gouldstone, Clare & Kragl, Gabriele & Traneus, E. & Marrale, Maurizio & Vatnitsky, Stanislav & Stock, Markus & Palmans, Hugo. (2018). End-to-end tests using alanine dosimetry in scanned proton beams. Physics in Medicine and Biology. 63. 10.1088/1361-6560/aaac23.
2. Elia, Alessio & Osorio Jhonattan & Dreindl Ralf & Bolsa-Ferruz Marta & Roisl Patrick & Stock Markus & Grevillot Loic. (2022) MedAustron Commissioning experience for an active scanning proton gantry beam line. [Conference presentation] PTCOG 60, Miami, FL, USA, 2022.