Commissioning of a Treatment Plan Couch Model Using a 3-Dimensional Dose Measurement System

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Introduction

To commission a treatment plan couch model using a 3-dimensional (3D) dose measurement system and to evaluate the dosimetric effect of the couch model. Couch correction can have a big impact in the real dose distribution of the patient dose due to the attenuation of the beam passing through the different materials. Incorrect couch modeling can lead to deviation on the dose calculations in radiation therapy.

Materials and Methods

The BrainLAB ExacTrac couch model of Eclipse treatment planning system (TPS) was commissioned for a Novalis Tx linac using a Delta4 Phantom+, ion chambers with solid water and CIRS IMRT QA phantom. Multiple open-field treatment plans with different beam angles were generated in 20x20x20cm solid water phantom. A Farmer ion chamber was placed at 11cm depth with SAD technique. 100MU is delivered with 10x10cm field size per each gantry angle. Various combinations of couch interior and exterior HU were tested as described in previous studies. Per each combination, the same solid water phantom with various beam angles were used to assess the dose differences. Meanwhile, doses measured with PinPoint ion chamber in the CIRS phantom was compared with those in TPS. In addition, four-field, IMRT and Rapid Arc treatment plans in Delta4 Phantom+ were also employed to verify the dose distributions using Gamma Index.

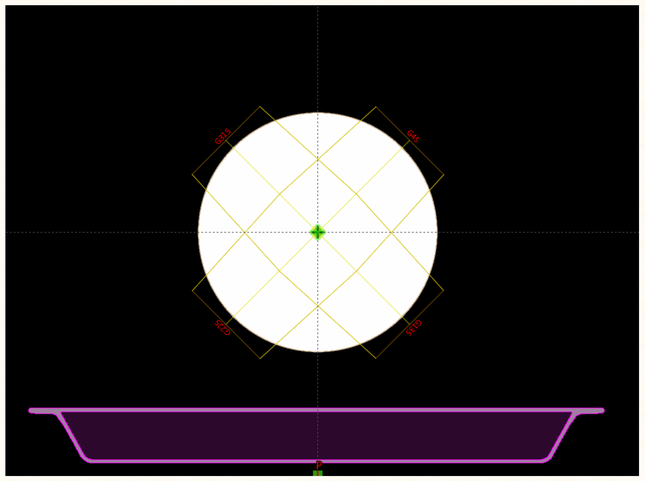

Figure 1. Delta4 setup with BrainLAB ExactTrac couch model in Eclipse TPS.

Results

The ideal combination of couch interior and surface HU were found to be -875 and -300 respectively. The dose discrepancies between TPS and ion chamber measurements was within 1% with both solid water and CIRS phantom with this setting. Dose distribution test using Delta4 Phantom+ was found to be 100% Gamma Index passing rate for all four field, IMRT and Rapid Arc plans with a 3%, 3mm gamma criteria.

Gantry Angle	TPS(-1000HU)	TPS (-875HU)	Measured Dose (cGy)	Mesurement vs TPS (-1000HU) Diff (%)	Mesurement vs TPS (-875HU) Diff (%)
0	79.7	79.7	78.245	0.000	0.000
45	74.6	74.6	72.692	0.746	-0.746
90	65.9	65.9	64.095	0.930	-0.930
135	69.5	67.4	65.033	4.688	-1.718
180	78	76.5	74.924	2.158	-0.239
225	69.4	67.4	65.624	3.683	-0.825
270	66	66	64.895	-0.154	0.154
315	74.7	74.7	73.437	-0.137	0.137

Figure 2. Calculated dose in TPS with default couch interior HU (-1000HU) and tuned couch (-875HU) and measured dose in CIRS IMRT QA phantom with Pinpoint chamber

Results (Cont')

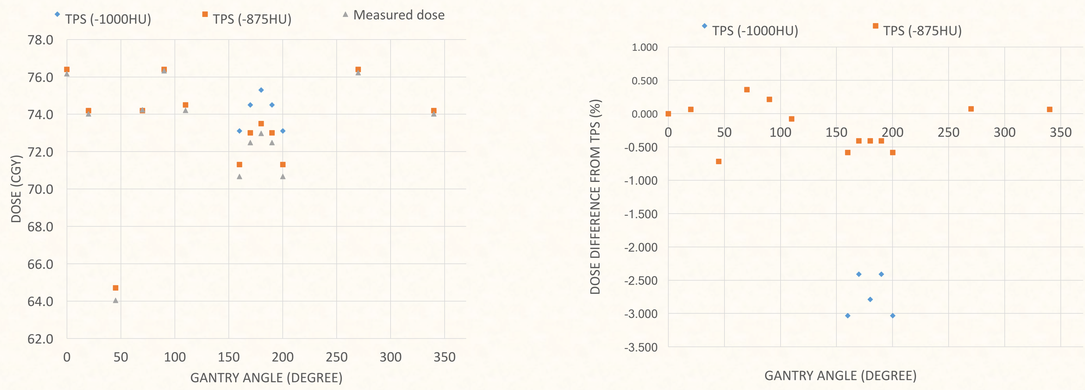

Figure 3. Calculated TPS doses with default couch interior HU(-1000HU) and tuned couch HU (-875HU) and Farmer chamber measured doses in 20x20x20cm solid water phantom. (a) TPS doses and measured dose; (b) Percent dose differences.

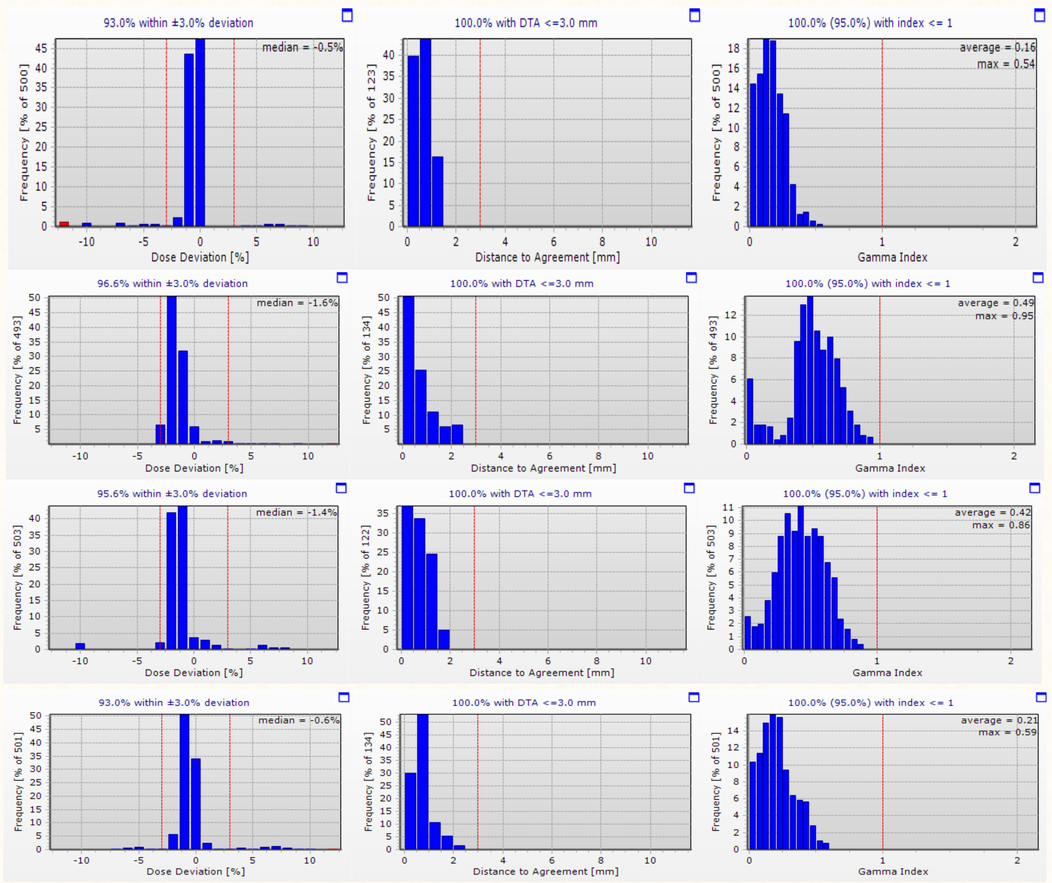

Figure 4. Gamma analysis results from Delta4 Phantom+ using 4-field box delivering 100MU in 10x10cm field at 4 different oblique gantry angles (45,135,225 and 315 degrees). Each row shows the results of Gamma index at each angle.

Conclusion

We successfully commissioned the BrainLAB couch model using Delta4 Phantom+ and ion chamber measurements. This work demonstrates that default TPS couch HU may not produce accurate dose distributions and consequently significant dose deviations may occur when incorrect couch HU are used. The 3D dose measurements using Delta4 Phantom+ was found to be essential for the commissioning task. The use of 3D dose measurements introduce a more accurate mode to evaluate the couch model.

Reference

1. Njeh et al. Radiation Oncology 2012, 7:190 http://www.ro-journal.com/content/7/1/190

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