

Transmission and Attenuation on 6DoF Couch under All FFF and FF Photon Beams

R. Foster and M. Xu

Northwestern Medicine Cancer Centers, Warrenville and Geneva, Illinois

INTRODUCTION

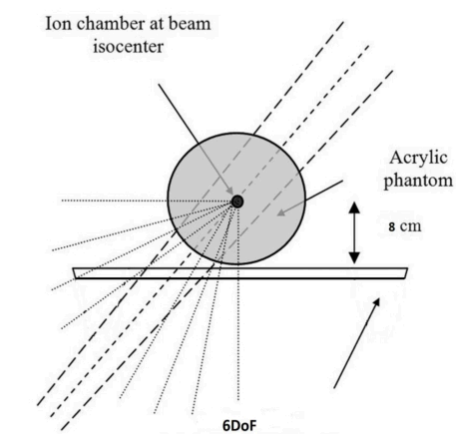
The objective was to evaluate transmission and attenuation factors for all 6 FFF, 6, 10 FFF, 10, and 15 MV photon beams through 6DoF-couch in TrueBeam linac. The attenuation would have an impact on percentage depth dose and, therefore, skin dose dependent upon gantry orientation.

AIM

This study provides detailed data of the couch for photon beams in TrueBeam. An evaluation following AAPM TG-176 guidelines for dosimetry of couch tops was made to assess modeled support structure within the TPS versus measurements acquired in this study.

METHOD

A polystyrene-cylindrical-phantom (8-cm diameter) with an ionization-chamber (IC) at isocenter was positioned on the 6DoF-couch made of carbon fiber as illustrated below. Transmission measurements were made using IC with gantry in posterior position 180° and 5 various angles with the photon beam passing through the couch.



RESULTS

The cylindrical phantom provided a symmetric geometry with gantry angular rotation and depth received radiation. A SAD setup with 6x6 cm² radiation field was used for all ion chamber charge collections in 6, 10, 15 MV and 6 and 10 MV FFF photon beams. Thin portion at H3 indexing location on the couch was used for measurements since thickness of the 6DoF couch was non-uniform along the longitudinal direction. Transmission charges were measured by IC with gantry in posterior position-180° and gantry angles relative to the posterior position at 150°, 135°, 120°, 115°, and 110° in Varian IEC scaling. For measuring beam without couch attenuation, the Farmer chamber (PTW) was placed in isocenter of the cylindrical phantom. A reference value was determined with a direct anterior beam (0° gantry angle), then beam was evaluated at 45°, 90°, and 270° gantry angles to confirm the cylindrical phantom and beam alignment. The transmission factor (Tr) = $D/D_0 = C/C_0$ where D and C are dose and charge at a gantry angle, and zero denoted the zero gantry angle in anterior position without the couch irradiated by the beam.

The transmission factors (Tr) were obtained by taking a ratio of charges measured with the beam passing through couch over those without couch. The attenuation factor(A) was derived from $A = 1 - Tr$ in percentage. The attenuation factor was found to be as high as 7.00% in thin portion of the couch at 110° gantry angle with 6 MV FFF photon beam. All transmission factors and attenuation factors were listed in the Table 1 and Table 2, respectively. The attenuation-factor was found as high as 7.00% in H3-location (thin portion of the couch) at 110° gantry angle with 6 MV FFF beam. For other beams, the attenuation-factor were found to be 5.84% for 6 MV, 5.20% for 10 FFF MV, 4.53% for 10 MV, and 3.71% for 15 MV at 110° gantry angle, respectively. The transmission and attenuation with the same dosimetry and geometry setup were calculated for all beams on 6DoF couch provided by AAA algorithm in Eclipse v15.6 TPS. Table 3 summarized the calculation results for Tr and A , in which an excellent agreement between the measured and calculated data was achieved within less than 0.65% in $Tr_{\%diff}$. The transmission and attenuation were calculated on 6DoF(IGRT) couch provided by AAA algorithm, in which an excellent agreement in calculation to measurement was achieved with less than 0.65% difference found in Tr .

Gantry	6 MV FFF	6 MV	10 MV FFF	10 MV	15 MV
180	0.9725	0.9791	0.9799	0.9835	0.9888
150	0.9669	0.9741	0.9755	0.9794	0.9850
135	0.9587	0.9672	0.9691	0.9741	0.9804
120	0.9406	0.9510	0.9550	0.9623	0.9695
115	0.9312	0.9428	0.9480	0.9559	0.9637
110	0.9300	0.9416	0.9480	0.9547	0.9626

Table 1: Measured transmission factors (Tr) on 6DoF couch for all beams in TrueBeam.

Gantry	6 MV FFF	6 MV	10 MV FFF	10 MV	15 MV
180	2.75%	2.09%	2.01%	1.65%	1.12%
150	3.31%	2.59%	2.45%	2.06%	1.50%
135	4.13%	3.28%	3.09%	2.59%	1.96%
120	5.94%	4.90%	4.50%	3.77%	3.05%
115	6.88%	5.72%	5.20%	4.41%	3.63%
110	7.00%	5.84%	5.20%	4.53%	3.74%

Table 2: Measured attenuation factors (A) on 6DoF couch for all beams in TrueBeam.

Gantry	6 MV FFF	6 MV	10 MV FFF	10 MV	15 MV
$Tr_{180,TPS}$	0.9788	0.9833	0.9853	0.9894	0.9948
$Tr_{\%diff}$	-0.65%	-0.43%	-0.55%	-0.59%	-0.60%
$A_{180,TPS}$	2.12%	1.67%	1.47%	1.06%	0.52%

Table 3: Transmission factor comparison of measured and calculated values in Eclipse 15.6 AAA.

CONCLUSIONS

Transmission measurements on 6DoF-couch are conducted for all photon FF and FFF beams on TrueBeam. The attenuation factor can reach 7.00% at gantry of 110° for 6 MV-FFF beam. Reliable values of Tr are obtained from both measurement and calculation. The couch structure should be included in a treatment planning and QA, especially in SRS and SBRT special procedures.

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CONTACT INFORMATION

Robert.foster@nm.org and Michael.xu@nm.org