Purpose: To investigate the tongue-and-groove (TG) effect in terms of the amount of underdosage and full width at half maximum (FWHM) at the interleaf position of dose profiles as varying off-axis distances and depths in water.

Methods: The Varian millennium 120 MLC was investigated by using Monte Carlo (MC) simulations, film measurements and treatment planning system (TPS) calculations for 6 MV photon beam. To estimate the TG effect, the MLC fields were overlapped at four off-axis distances of 0, 5, 10, 13 cm. The TG effect was estimated at 1.5, 5, and 10 cm depths in water, compared to dose profiles of the open field. The BEAMnrc and DOSXYZnrc code were used to simulate the in-water dose distributions. The measurements were performed using the radiochromic films. The Varian TPS calculated the 3D dose distributions for the same MLC fields.

Results: The results from the MC and film were in good agreement. Compared to the open field, the amount of TG underdosage for both methods generally decreased with increasing off-axis distances and depths; approximately 9%-16% at 1.5 cm depth and 5%-11% at 10 cm depth depending on off-axis distances. However, the TPS results showed the almost same amount of underdosage regardless of off-axis distances; 8%-9% at 1.5 cm depth and 6%-7% at 10 cm depth. The FWHM at the interleaf position slightly increased with increasing depths. It was determined to be 0.31 cm on average for the MC and film but 0.63 cm for the TPS.

Conclusions: There was the fair agreement between MC simulations and film measurements in estimating the TG effect for the 120 MLC. Since the TPS underestimated the TG effect, our results from the MC and film can be useful data to correct some modeling parameters for the 120 MLC in the TPS.