Optimal selection of plane and alignment based on quantitative evaluation using three-dimensional (3D) dose data for IMRT and VMAT dosimetry

**Background and purpose:** In IMRT and VMAT plan verification dosimetry, two-dimensional (2D) plane of dose calculation is compared with the same plane of the measurement with the isocenter alignment. Gamma, DTA and dose difference (DD) evaluations could take into account for only the two axes on the plane [1]. However, steep dose gradient region on another axis can affect to decrease the agreement between the calculation and measurement even though with small deviations of the measurement setup. In this study, we design and implement a framework of finding optimal plane of the evaluation and adequate alignment of the measurement data using 3D dose data.

**Materials and Methods:** The measurement data from film or 2D-detector arrays and 3D-calculated dose data from treatment planning system are utilized. A schematic representation was shown in Fig. 1. At first the measurement plane is aligned using marks of isocenter indication as usual and then the measurement data with the alignment is registered as the reference plane data for the optimal selection method. After the optimal selection engine is started, the engine reconstructs several dose planes from the 3D dose data. The dose planes are generated at certain locations on the axis perpendicular to the evaluation plan. Then, the calculation planes are compared with the measurement plane using gamma evaluation. Using the candidates with the combinations with rotations and shifts, DD evaluation is conducted to find out the best plane and the best combination of shift and rotation for the measured data.

To evaluate the effectiveness of the method, a head and neck IMRT plan measurement was performed with EDR2 film. With and without the optimal selection method, 2D maps of DD and gamma evaluation were assessed and path ratios of DD (3% criteria) and gamma evaluation (3%/3mm criteria) were measured.

**Results:** The result of the 2D maps of both DD and gamma evaluation showed the area of the agreement with the optimal selection became larger than without the method (Fig.2). Pass ratios of dose difference and gamma evaluation at each dose region (30% to 100%) were shown...
In DD evaluation, the values with the optimal selection method showed more than 10% better agreements than without the method. In gamma evaluation, the values with the method showed better agreement than without the method. Especially, the pass ratio at 30-40% dose region was 20% increased compared to without the method. The average values of the path ratio of DD and gamma evaluation are 12.9% and 14.1% better with the optimal selection method than with non-selection method, respectively. Additionally, the method found that the deviations of the isocenter alignment were 0.5mm and 1.5mm in the two-axis on the evaluation plane without any rotation, respectively. 1.0mm deviation was also measured on the axis perpendicular to the plane. The isodose curves of the measurement data with the method also showed better agreement with the curves of the calculation data (Fig 3).

**Conclusions:** The method could assist us to quantitatively find out the best plane and the best alignment for the better agreement and also the amount of isocenter shifts in the measurement. This means that the measurement with the method could also give us the information of isocenter mechanical shifts of the laser. Therefore, IMRT and VMAT verification measurement with the method could provide us not only the dosimetric check of the plan but also the mechanical test of isocenter laser alignment.

**Reference:**