Evaluation of IsoCal Imaging Isocenter Calibration System for Varian OBI Machines

The coincidence of kV/MV image centers and radiation treatment isocenter is essential for high-precision image guided treatments of linacs with kV OBI-CBCT and MV EPID imaging system. IsoCal calibration (Fig.1) enables the quantification and correction of the differences between the kV/MV image centers and treatment isocenter.[1]

Fig.1. IsoCal phantom and IsoCal collimator plate.

We evaluated the IsoCal calibrations on five OBI linacs. IsoCal software reported the shifts between treatment isocenter and kV/MV image centers. These shifts were represented as 2D vectors (x, y), which indicated the lateral and longitudinal shifts, respectively. IsoCal also generated the minimum shift x_1, y_1 and maximum shifts x_2, y_2 for a full gantry rotation. The shifts of three calibrations for one linac are showing in Fig.2. Similar results found in others calibrated linacs. These results showed that IsoCal calibrations were very stable.

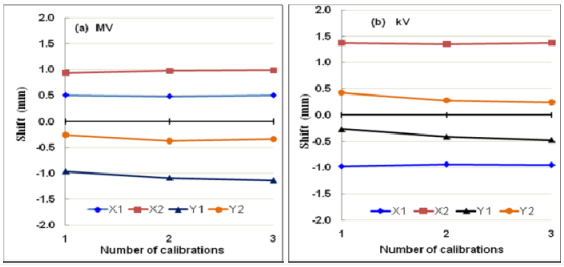

Fig.2. Lateral and longitudinal shifts between MV/kV image center and treatment isocenter for 3 calibrations. (a) MV image, (b) kV image.

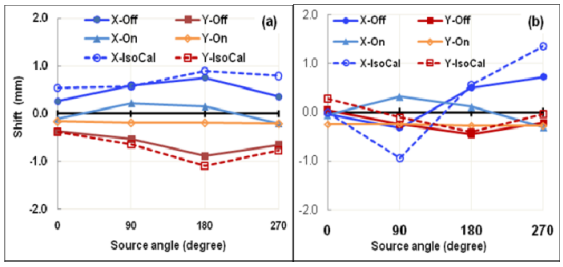

Fig.3. Shifts between MV/kV image center and treatment Isocenter at selected source angles. IsoCal (X-IsoCal) vs. WL method (X-off, X-On). (a) MV image, (b) kV image.

Independent checks IsoCal calibration: We used two different methods to check IsoCal calibrations. One is using a Winston-Lutz based (WL) method, a metal ball bearing (BB) was imaged with MV and kV x-ray beams.[2] The shifts between MV/kV image center and treatment isoccenter were determined with IsoCal correction on and off, and the results showed in Fig. 3. With IsoCal correction off, WL-based method agree with Isocal within 0.5 mm for MV image and 0.65 mm for kV images. With IsoCal correction on, the results of the WL indicate the reductions of the shifts for both kV and MV images.

Another method was to use a Varian cube based (VC) procedures.[3] To reduce setup errors, we calculated the differences of the MV/kV images center shifts with IsoCal on and off, and compared to the results of WL-based method, the results are showed in Fig.4. The agreements of two methods for both MV and kV images were within 0.5 mm.

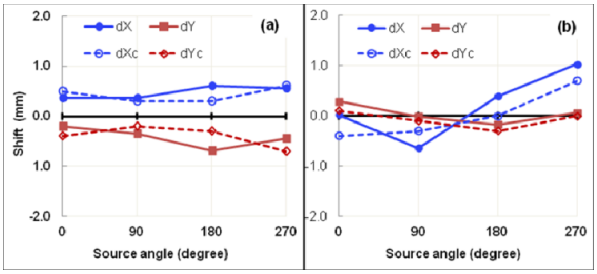

Fig.4. Differences of shifts between IsoCal correction 'On' and 'Off' at selected source angles. WL (dX, dY) vs. VC (dXc, dYc). (a) MV image, (b) kV image.

Reference

[1] Varian medical systems, On-Board Imager (OBI) maintenance manual, chapter 10. (2010)

[2] W. Du, J. Yang, D. Luo, and M. Martel, "A simple method to quantify the coincidence between portal image graticules and radiation field centers or radiation isocenter," *Med. Phys.* **37**, 2256–2263 (2010).

[3] S. Yoo, G. Y. Kim, R. Hammoud, E. Elder, T. Pawlicki, H. Guan, T. Fox,G. Luxton, F. F. Yin, and P. Munro, "A quality assurance program for the on-board imagers," *Med. Phys.* **33**, 4431–4447 (2006).