Significant inter-fractional variations of lumpectomy cavity in partial breast irradiation

Lumpectomy cavity volume change and deformation can be a major component of inter-fractional variations for breast cancer RT. The volume change and deformation can hardly be alleviated by using IGRT. This work is to examine those variations challenging IGRT by analyzing the data collected from ten patients treated with PBI.

Figure 1 shows the lumpectomy cavity volume ratio, calculated by dividing the lumpectomy cavity volume in daily CT by that from the plan CT. Each curve represents the data from one patient. Compared to the plan CT, the lumpectomy cavity volume is reduced significantly in the first fraction, and then remains relatively stable through the rest of 9 fractions.

Maximum overlap ratio (MOR) and dice’s coefficient were calculated to measure the organ deformation and rotation. Figure 2 shows the MOR values for the 10 patients, demonstrating similar trends to Figure 1, varying depending on the patient, from 50% to 90%. Similar results can also be observed in for the dice’s coefficient. Although the breast volume does not change (99% ± 4%) and has relatively small variations in shape with an average MOR of 93%, the distance between lumpectomy cavity COM and breast COM fluctuates around 3 mm, as illustrated in Figure 3. A similar fluctuation is also seen for the distance between lumpectomy cavity and heart. This relative shift of the organ position also cannot be addressed by IGRT repositioning.

Inter-fractional anatomic variations in the supine PBI are significant enough to warrant attention and suggesting adaptive RT be considered in future work.