Structured Abstract:

Background: Adjuvant whole breast radiotherapy (RT) is a standard of care after conserving surgery of breast cancer to increase overall survival. Modern techniques including intensity-modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) have been shown to provide higher target coverage and better sparing of critical organs. However, a proportion of breast cancer survivors develop radiation-induced cardiac disease later in their cure life. Hence, other techniques such as deep-inspiration breath-hold (DIBH) have been implemented in the RT routine at many centres to further reduce cardiac exposure to irradiation, but requires patient compliances. The Raystation treatment planning system (RaySearch Laboratories) 4D-CT Robust optimization technique can account for heart intrafractional motion at each breathing phase. This technique has not been used in the context of cardiac sparing for breast RT. In order to provide patients with the efficient approach and optimal treatment outcome, various treatment techniques and heart sparing extent has to be evaluated for both statistical and clinical significance.

Aim: This retrospective study aimed to provide an extensive dosimetric heart sparing comparison among various treatment planning techniques including DIBH, forward and inverse IMRT and VMAT robust optimization for treating left-sided breast cancer with radiotherapy.

Methods: 10 early stage left-sided breast cancer standard treatment plans were selected. Both DIBH and 4D-CT simulation imaging were performed. Tumour volume, left anterior descending artery (LAD), left ventricle (LV), and the heart were contoured using Raystation7 software. Each patient treatment plan was retrospectively optimized using forward; inverse-IMRT and VMAT on following CT datasets: average 4D-CT, entire 4D-CT for robust optimization and the DIBH dataset. Dose-volume histograms were used to compare dosimetric parameters, including LungV50%, HeartV5% and the mean dose of the heart, LAD and LV. Statistical analyses were performed in IBM SPSS using Kruskal-Wallis One-way analysis of variance tests.

Results: Kruskal-Wallis test showed a statistically significant difference in dosimetric parameters of mean heart, LAD and LV dose, and heartV5% between different treatment techniques, p=0.03. While LungV50% were statically equal among treatment techniques p=0.312. Mann-whitney test showed that both forward and inverse IMRT considered statistically equal for all the dosimetric parameters. IMRT DIBH achieved the optimal cardiac sparing among treatment plans with a mean dose of 72.55±38.83cGy to heart, 272.93±362cGy to LAD, 102.65 ±78.3cGy to LV and 5.09±3.85% to heartV5%.

Conclusion: This study demonstrated that IMRT DIBH technique was dosimetrically advantageous in heart sparing in treating early-staged left sided breast cancer patients compared to standard 4D-CT and DIBH based VMAT, 4D-CT robust and other IMRT treatment techniques.