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Second cancer risk evaluation after left-sided breast Radiotherapy using different protocols and treatment techniques

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1. Background-Aim

Post-operative whole breast radiotherapy (RT) appears to minimize the risk of cancer recurrence and local regional tumor elapse. Modern RT techniques enhance dose conformity and reduce dose to organs-at-risk (OARs).

This study aims to perform assessments to evaluate the clinical impact of left-sided breast cancer in terms of second cancer risk induction for critical structures in 45-year-old female patients.

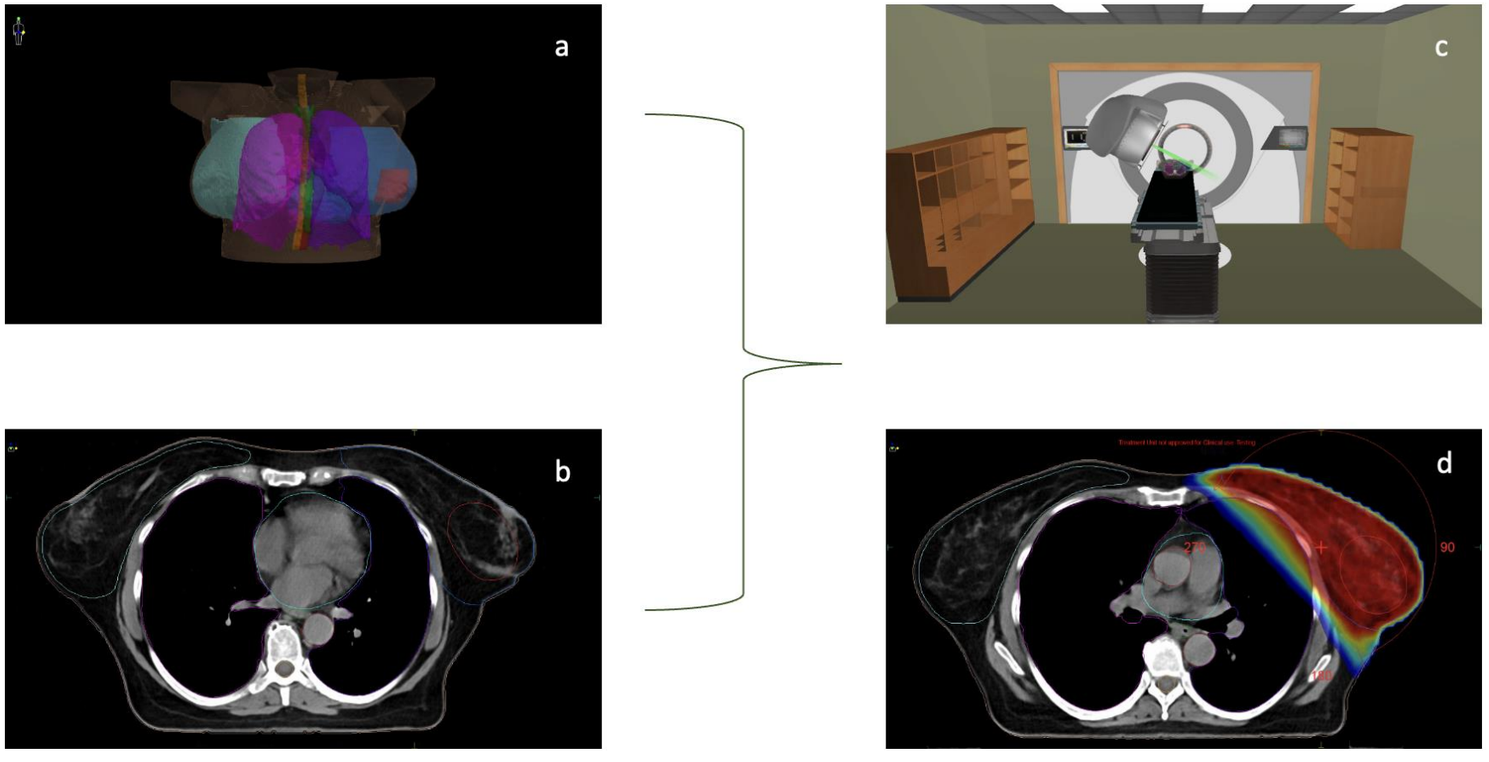


Image 1.1: *Visualization of the post-operative radiotherapy process.*

2. Materials & Methods

1) Eight anonymized patients underwent planning CT scans in deep-inspiratory breath-hold with the active breathing coordinator (ABC)

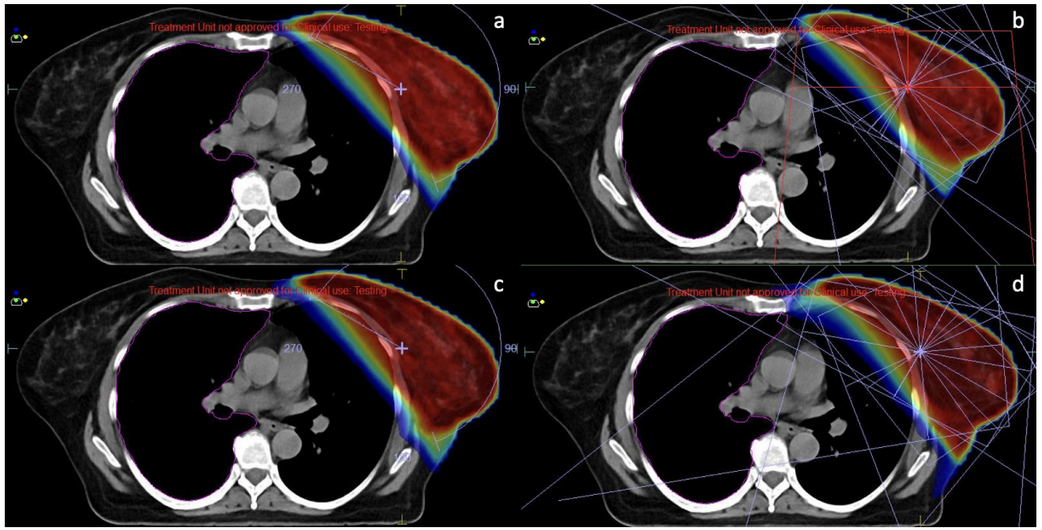


Image 2.2: *a,c) VMAT and b,d) IMRT treatment plans using 50Gy and 40Gy prescription doses, respectively.*

3) The quality of the plans, along with the estimation of induced second cancer risk for the ipsilateral lung, contralateral breast, and lung, were estimated using the DVHs and the formula introduced by ***Schneider U. et al. Biol. Med. Model. 2011, 8, 27***

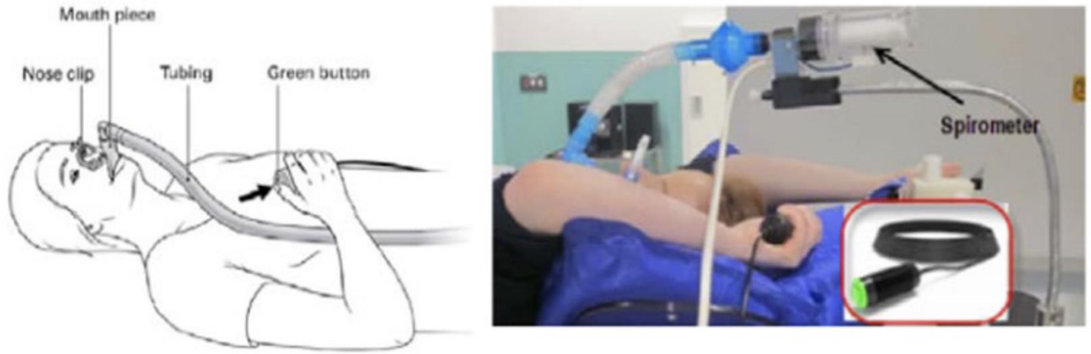


Image 2.1: *CT scanning preparation in DIBH using ABC .*

2) Plans for each patient were created on Monaco treatment planning system (ELEKTA, Crawley, UK) for both 50Gy (25X2Gy) and 40Gy (15X2.67Gy) protocols, utilizing 6MV photon beams

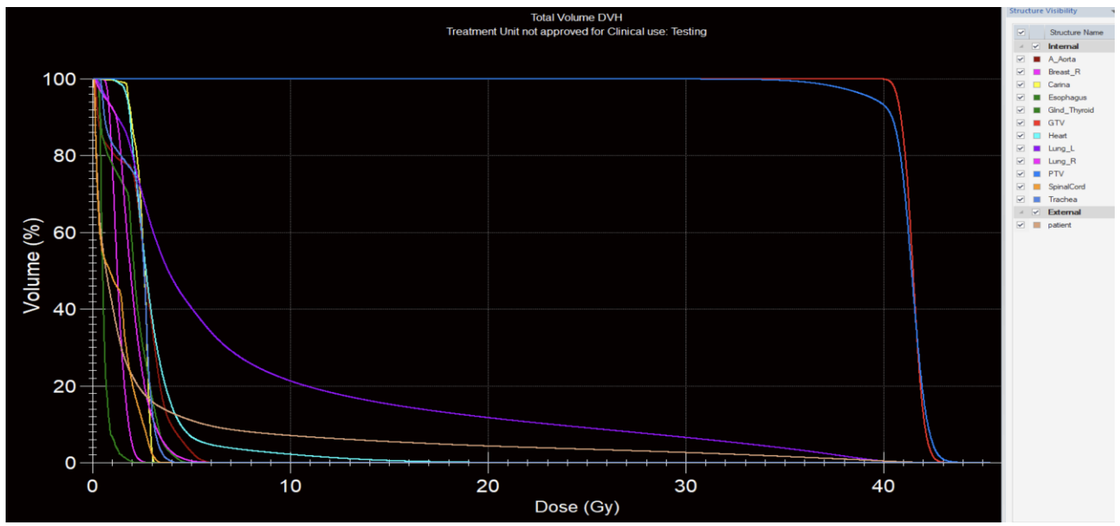
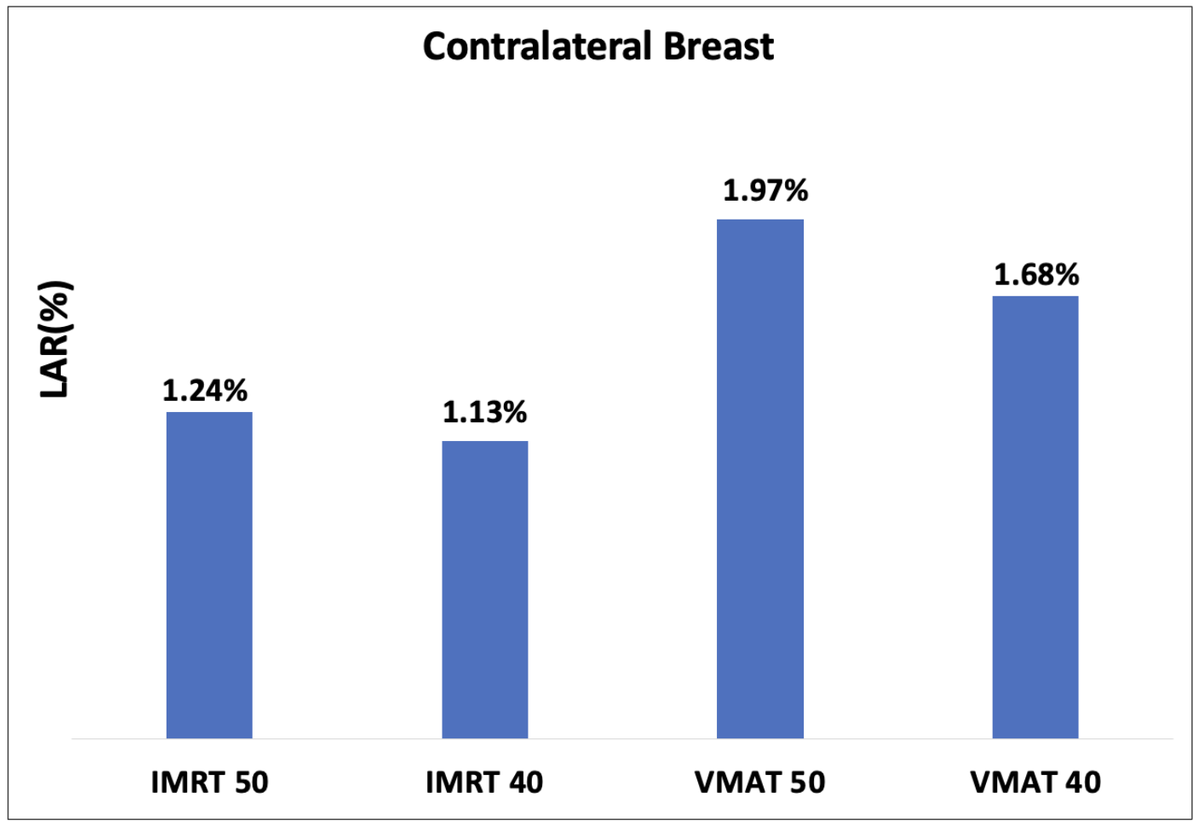


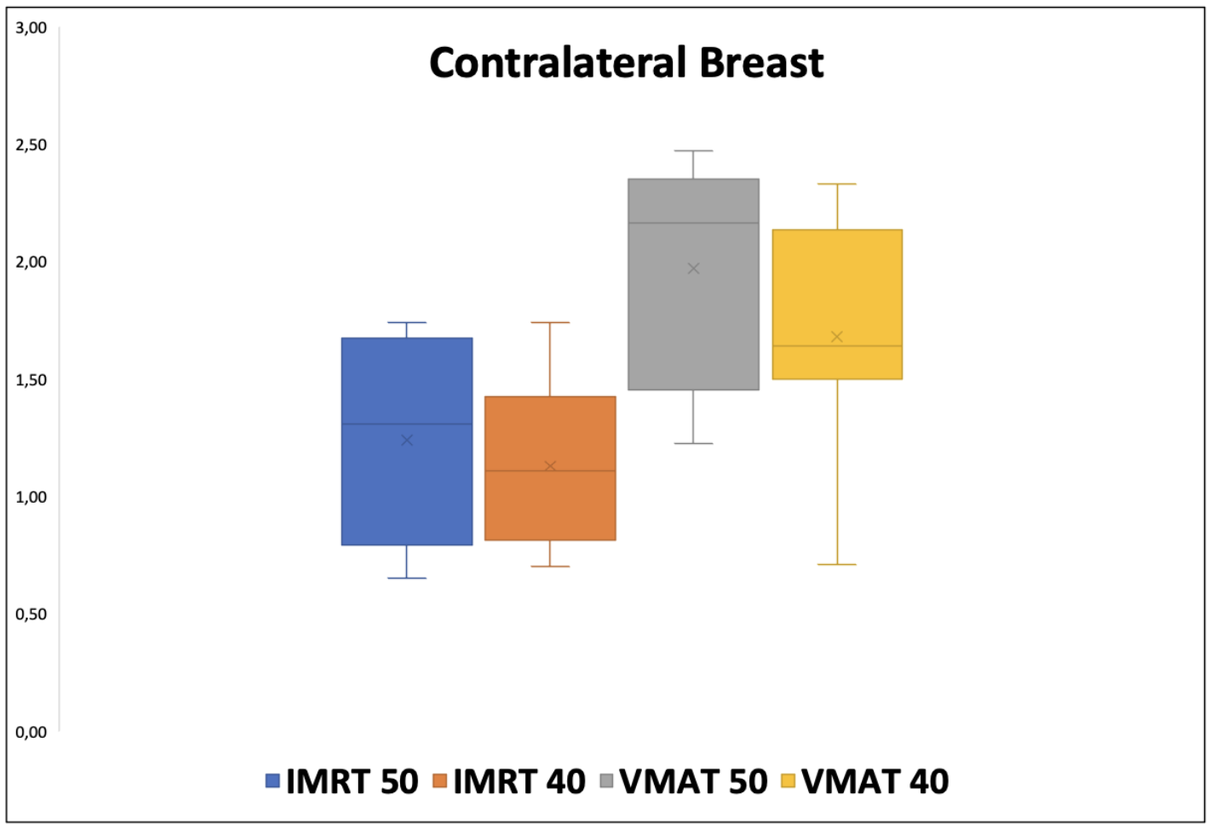
Image 2.3: *DVH generated from IMRT 40Gy plan.*

3. Results

- LAR(%) values, regardless of protocol or technique range between 1.13% - 1.97%
- The maximum LAR(%) value is observed for the 50Gy protocol
- Additionally, VMAT increases the estimated second cancer risk for the contralateral breast



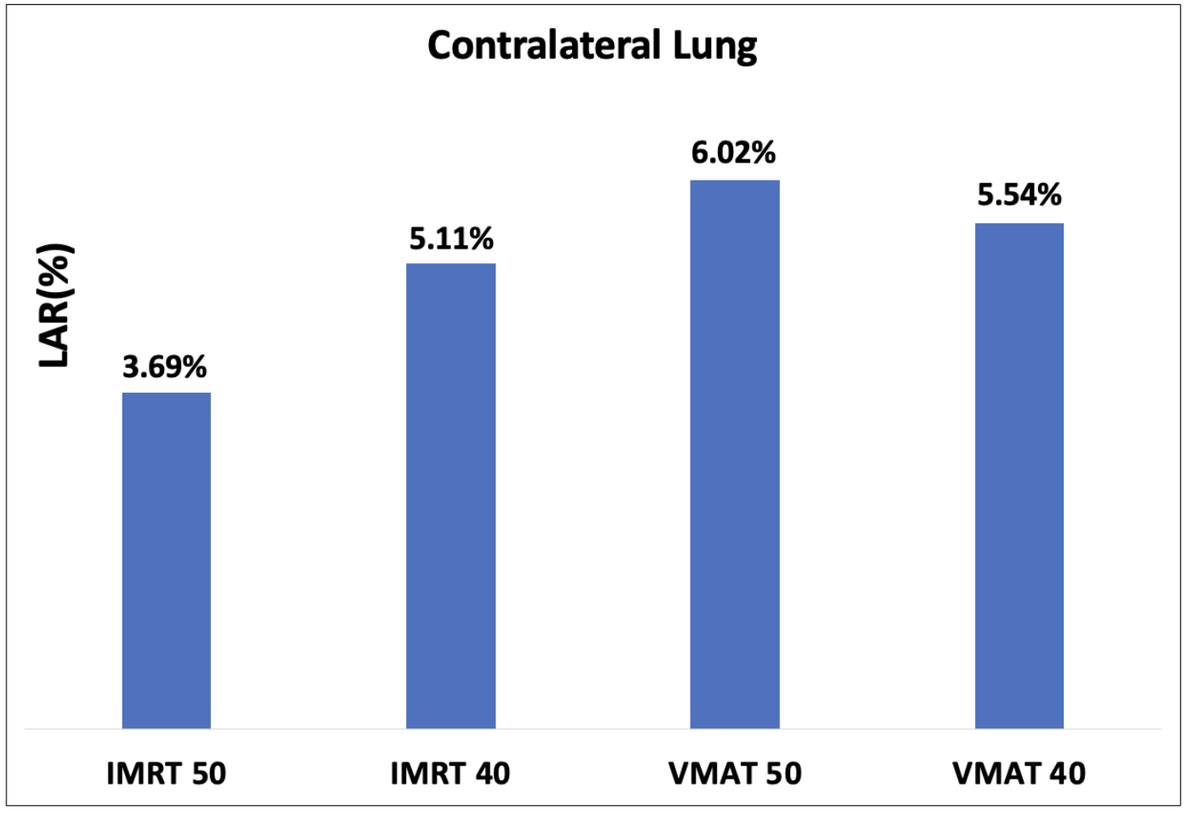
Plot 1.1: *LAR (%) average estimations for each applied protocol and technique.*



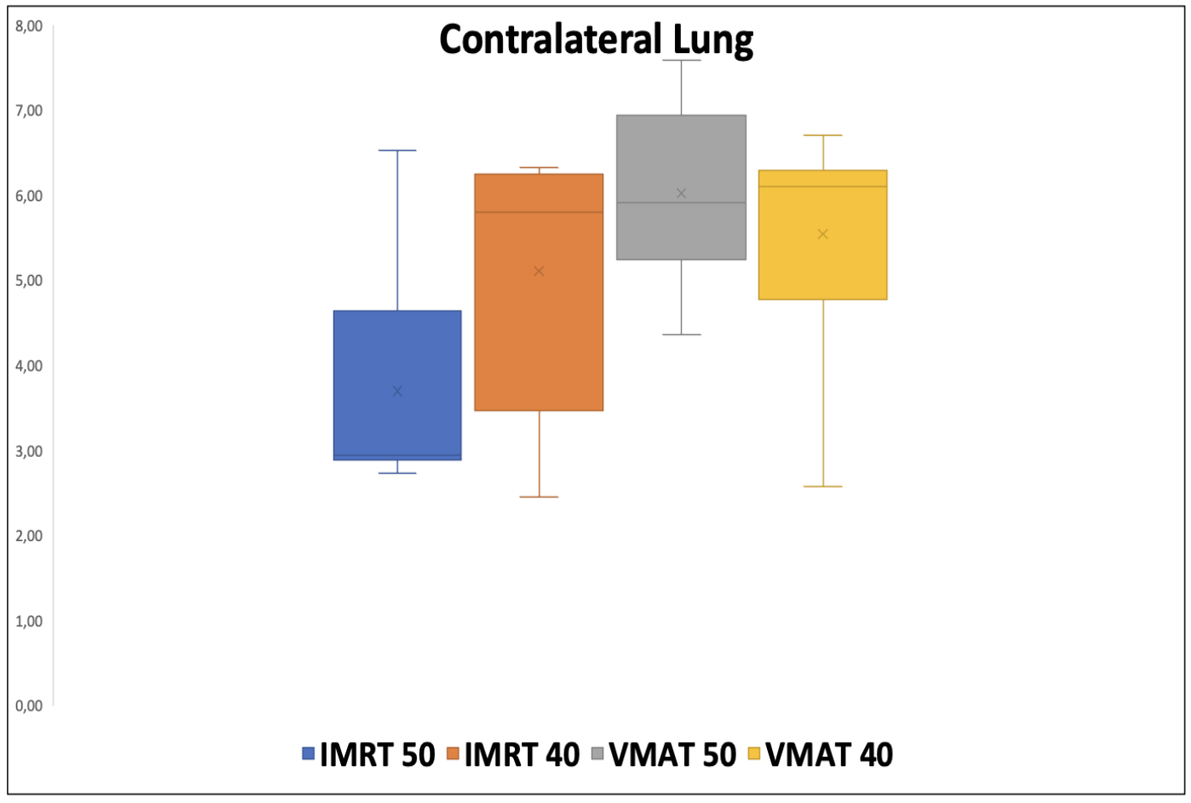
Plot 1.2: *Box-and-Whisker plots illustrating LAR (%) assessments for each patient, categorized by different techniques and protocols.*

3. Results

- LAR(%) values ranged between 3.69% - 6.02%
- Using the conventional protocol (25X2Gy), LAR (%) reaches a maximum value of 6.02%
- VMAT raises the estimated risk of secondary cancer for the contralateral lung



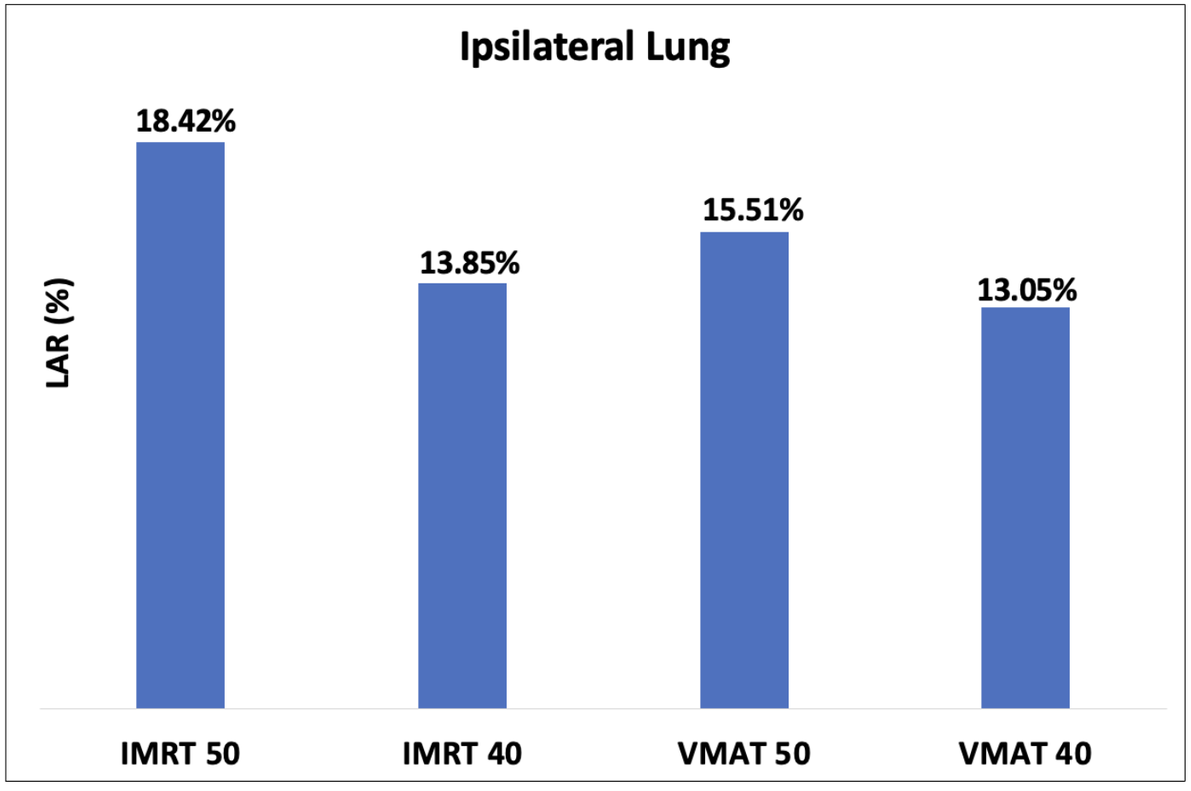
Plot 1.3: *LAR (%) estimations related to each applied protocol and technique.*



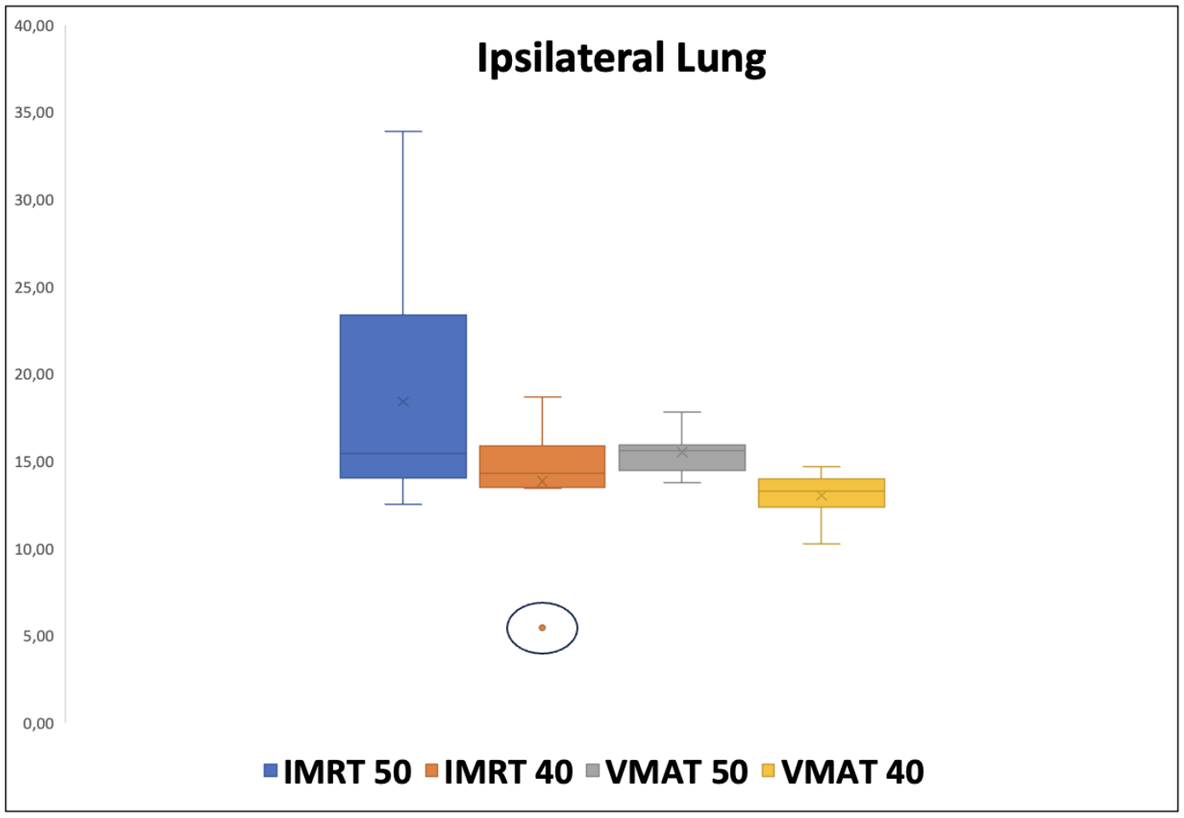
Plot 1.4: *Box-and-Whisker plots derived from LAR (%) estimations related to different plans.*

3. Results

- LAR (%) values, irrespective of the technique used, range from 13.05% to 18.42%
- An increase in LAR (%) is observed when the 50Gy protocol is applied
- Additionally, IMRT heightens the estimated risk of secondary cancer for the ipsilateral lung



Plot 1.5: *LAR (%) estimations for each applied protocol and technique.*



Plot 1.6: *Box-and-Whisker plots displaying LAR (%) assessments for each patient in different plans and an outlier is observed for VMAT 40.*

4. Conclusions

1) For the contralateral organs, such as the breast and lung, VMAT is associated with an increased risk of secondary cancer, regardless of the treatment protocol used

2) The VMAT technique increases the estimated LAR(%) for the contralateral structures due to the higher low-dose radiation (low-dose-bath) exposure

3) For the ipsilateral lung, which is an organ located within the primary radiation field and portions of its volume receive high doses, IMRT increases the risk of secondary cancer and creates statistically significant differences in the estimated LAR (%) between the techniques

4) Regardless of the technique used, the conventional protocol of 50Gy in 25 fractions increases LAR (%) values for all organs at risk, with the rise in LAR being proportional to the risk of radiation-induced cancer

5) The secondary cancer risk assessment in women undergoing left–sided breast radiotherapy is very important, especially for younger patients with higher life expectancy, so that the treatment can be tailored even more individually by evaluating the secondary risk to healthy organs in each patient.

5. References

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