3° Πανελλήνιο Συνέδριο
Ιατρικής Φυσικής

27° Διαπανεπιστημιακό Συνέδριο
Ακτινολογίας

Comparative Radiobiological Analysis of Second Cancer Risk Following Conventional and Hypofractionated Radiotherapy for Rectal and Breast Cancer

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ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΥΓΕΙΑΣ
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Οργάνωση

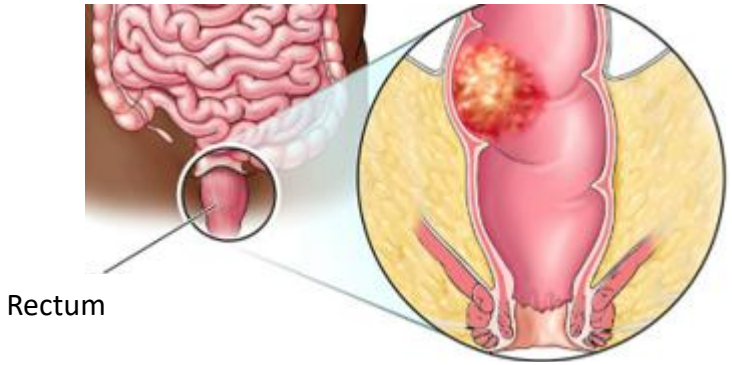
ΕΦΙΕ
Ένωση Φυσικών Ιατρικής Ελλάδος

ΕΛΛΗΝΙΚΟ ΚΟΛΛΕΓΙΟ ΑΚΤΙΝΟΛΟΓΙΑΣ

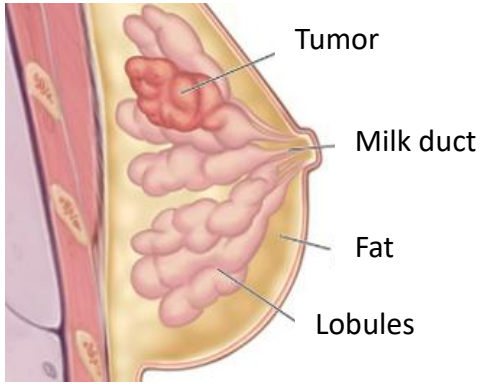
Introduction

Hypofractionated radiotherapy is increasingly used in clinical practice, as it may offer comparable local tumour control while substantially reducing the number of treatment fractions required. However, its impact on the stochastic risk of radiation-induced cancer remains unclear.

Rectal Cancer



Left-sided Breast Cancer

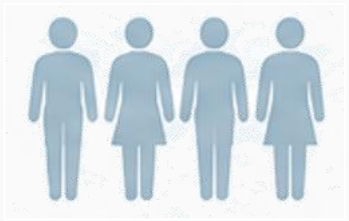


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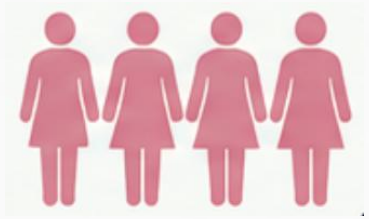
This study aimed to compare the effects of dose fractionation and radiotherapy delivery technique on the risk of radiation-induced second cancer following radiotherapy for rectal and left-sided breast cancer, using a well-established nonlinear mechanistic radiobiological model.

Methods & Materials

Retrospective analysis

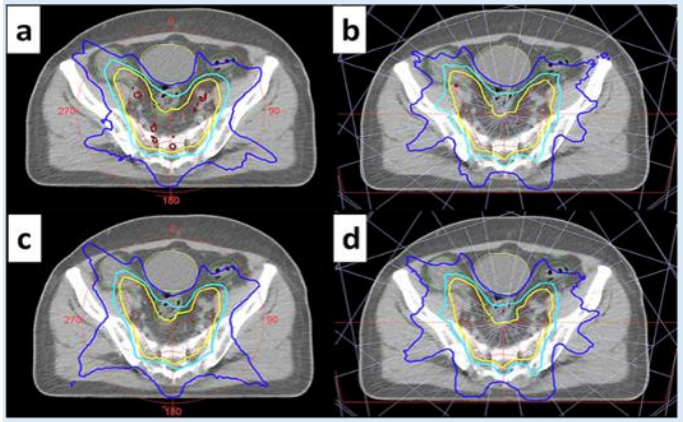


16 rectal cancer patients



20 left-sided breast cancer patients

Rectal Cancer

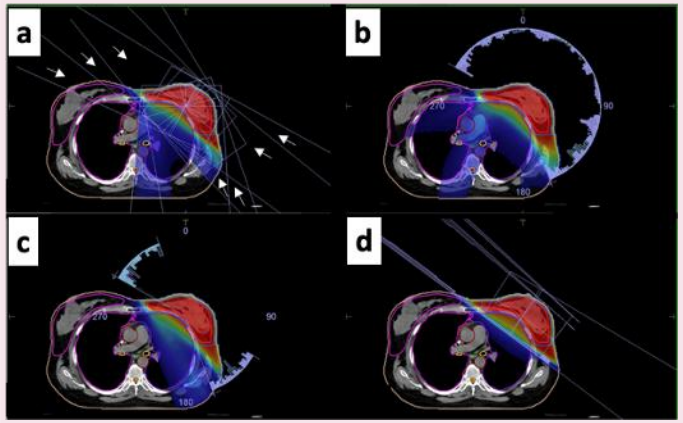


Treatment planning in Monaco (Elekta, UK)

Conventional fractionation(CFRT; 25 × 2 Gy) and hypo-fractionation (HFRT; 5 × 5 Gy) were evaluated using Intensity-Modulated Radiotherapy (IMRT) and Volumetric-Modulated Arc Therapy (VMAT).

(a,c) VMAT and (b,d) IMRT delivery techniques, (a,b) CFRT (25 × 2 Gy) and (c,d) HFRT (5 × 5 Gy) fractionation schemes.

Left-sided Breast Cancer



Treatment planning in Monaco (Elekta, UK)

Conventional fractionation (CF; 25 × 2 Gy), moderate hypofractionation (mHF; 15 × 2.67 Gy), and ultra-hypofractionation (uHF; 5 × 5.2 Gy) were assessed using Field-in-Field (FINF), IMRT, VMAT, and VMAT-Bow Tie under deep inspiration breath-hold (DIBH) conditions.

(a) 7-field IMRT, (b) VMAT, (c) VMAT-BT, and (d) FINF delivery techniques for CF (25 × 2 Gy).

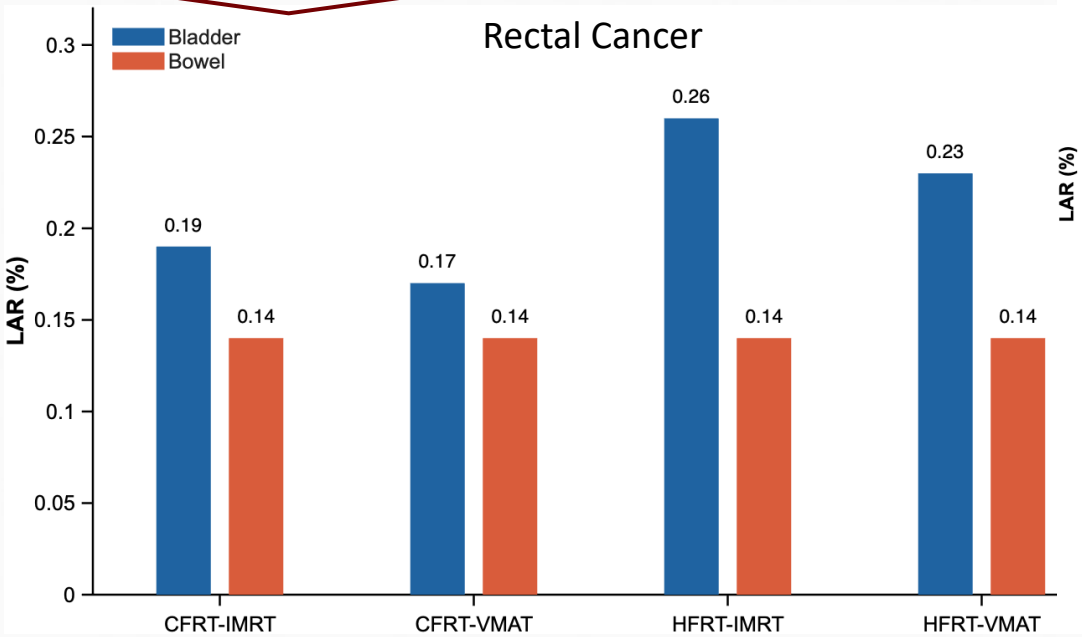
Radiation-induced second cancer risk (SCR)

The estimated lifetime attributable risk (LAR) was calculated using the mechanistic model by Schneider et al.[4] assuming an age at treatment of 45 years for all patients.

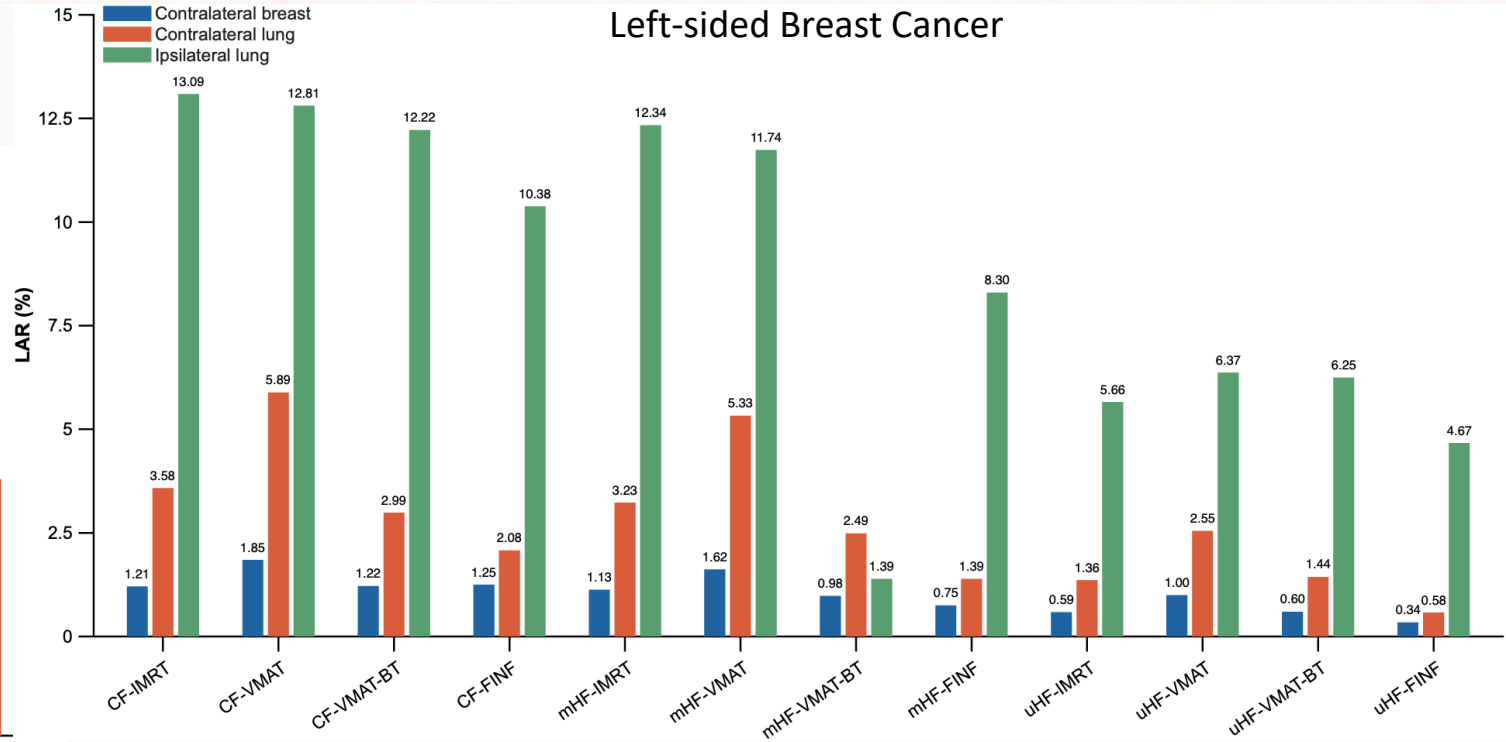
Rectal Cancer: SCR estimations for bladder and bowel.

Left-sided breast Cancer: SCR estimations for contralateral breast and lung, and ipsilateral lung.

Results



- LAR (%) values for the bladder were higher with HFRT than with CFRT, regardless of the delivery technique (IMRT or VMAT).
- Bladder LAR (%) values were slightly increased with IMRT.
- Bowel LAR (%) values remained constant at 0.14% across all fractionation schemes and delivery techniques.



- LAR (%) values were comparatively lower for the contralateral breast (0.34% - 1.85%), and consistently higher for the ipsilateral lung (4.67% - 13.09%).
- Contralateral lung LAR (%) values varied across fractionation schemes and delivery techniques, with the highest LAR (5.89%) for CF and VMAT.
- uHF and FINF were associated with lower estimated LAR (%) values for all three organs.

Conclusions

- In rectal cancer, hypofractionation (HFRT; 5 × 5 Gy) resulted in higher estimated bladder LAR (%) values, while VMAT was associated with slightly lower bladder LAR (%) than IMRT.
- Bowel LAR (%) values remained similar across all assessed treatment plans.
- In left-sided breast cancer, the estimated LAR (%) was substantially higher for the ipsilateral lung than for the contralateral breast and lung across all treatment plans.
- In left-sided breast cancer, ultra-hypofractionation (uHF; 5 × 5.2 Gy) combined with the Field-in-Field (FINF) technique resulted in the lowest estimated LAR (%) across the three examined organs.
- The estimated risk of radiation-induced second cancer varied according to the irradiated anatomical site, organ of interest, dose fractionation, and delivery technique.
- Radiobiological risk assessment may support treatment plan optimization and improve the selection of appropriate fractionation schedules and delivery techniques.

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