Personalizing Radiotherapy for Left-Sided Breast Cancer: Identifying Candidates for Proton Beam Therapy Based on Cardiac Risk

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Introduction

- ✓ **Young patients with left-sided breast cancer** face a higher long-term risk of major cardiac events due to incidental cardiac radiation exposure and cardio-toxic systemic therapy agents.
- ✓ **Mean heart dose (MHD)** of ≥3 Gy is associated with at least a 2% increase in the risk of major cardiac events (*Kirby et al., 2023*).
- ✓ This study aimed to **stratify patients** based on their risk and identify those most likely to benefit from **proton beam therapy (PBT),** a modality recently introduced at our tertiary care cancer center.

Methodology

- ✓ Records of **737 patients** with stage I–III or oligometastatic breast cancer treated with adjuvant radiotherapy in 2023 were reviewed.
- ✓ A **dosimetric audit** was conducted for all left-sided cases. Treatment used IMRT or field-in-field 3DCRT, with or without DIBH. Fractionation included 40 Gy/15 fx, 26 Gy/5 fx, or 28.5 Gy/5 weekly fx, with boost as indicated.
- ✓ Patients were stratified per **UK PARABLE risk criteria**.
- ✓ Statistical analysis was performed using IBM SPSS v28, with Chi-square tests and significance set at $p < 0.05$.

Results

Risk Factor	Age Group	Target MHD	Desired Dose Achieved	Not Achieved	Total	p
Yes	**<44**	**≥2.5 Gy**	**18 (66.7%)**	**9 (33.3%)**	**27**	
	45–54	≥4.0 Gy	60 (98.4%)	**1 (1.6%)**	61	
	55–64	≥4.5 Gy	52 (98.1%)	**1 (1.9%)**	53	**<0.001**
	65+	≥5.5 Gy	27 (100%)	0 (0%)	27	
Subtotal			**157 (93.5%)**	**11 (6.5%)**	**168**	
No	**<44**	**≥4.0 Gy**	**126 (97.7%)**	**3 (2.3%)**	129	
	45–54	≥6.0 Gy	91 (100%)	0 (0%)	91	
	55–64	≥6.0 Gy	38 (100%)	0 (0%)	38	0.326
	65+	≥6.0 Gy	18 (100%)	0 (0%)	18	
Subtotal			**273 (98.9%)**	**3 (1.1%)**	**276**	
Total			**430 (96.8%)**	**14 (3.2%)**	**444(100%)**	

- ✓ **Risk factors -** 69.3% were under the age of 55. Cardiac comorbidities (22.3%) and diabetes (19.8%) were the most prevalent risk factors, while COPD (1.6%) and smoking (5.6%) were less common. Most patients (84.5%) had a BMI below 30.
- ✓ **Fourteen patients (3.2%) did not achieve the age- and risk-adjusted desired MHD** using photon techniques and could potentially benefit from proton therapy.
- ✓ **Among those with risk factors, 6.5% did not meet their MHD thresholds**. In contrast, only 1.1% of patients without risk factors failed to achieve the desired MHD.

Conclusion

Proton therapy may benefit left-sided breast cancer patients at high cardiac risk—especially younger individuals with comorbidities or unfavorable anatomy unable to meet heart dose with photons. Risk-adapted selection supports optimal cardiac sparing and ensures equitable, cost-effective use of this limited resource.