Experience of Hybrid Planning Technique in Breast Cancer Radiotherapy

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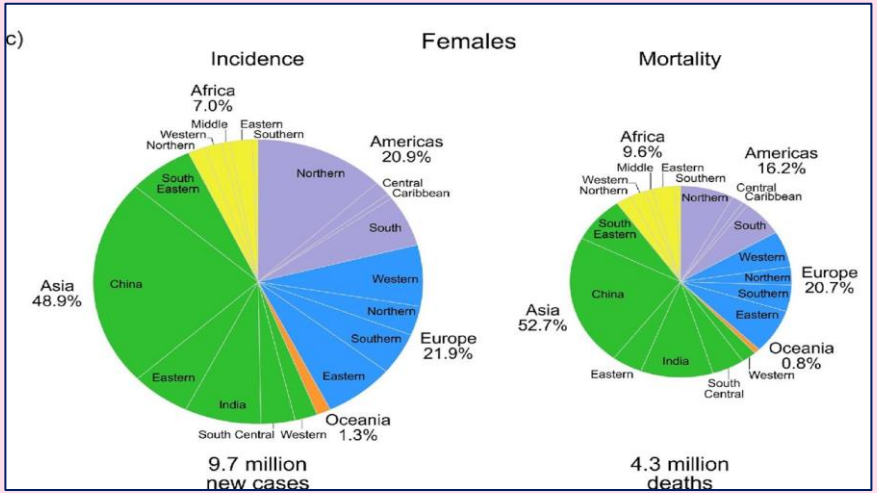
Key Focuses

- Basics of Hybird VMAT
- Comparison of 3DCRT, VMAT and Hybrid Planning
- Clinical benefits, dosimetric considerations and outcomes
- Summary

Breast Cancer Quick Facts

GLOBOCAN cancer incidence and mortality for 36 cancers in 185 countries



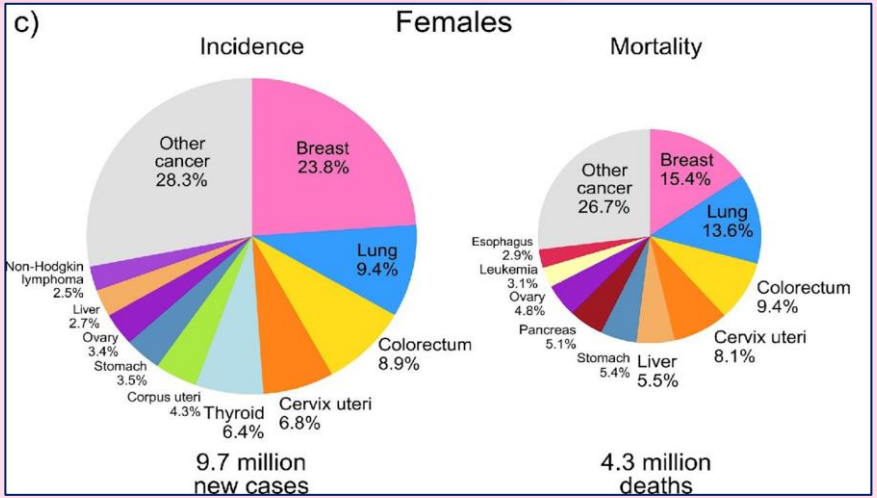


TABLE 1 New cases and deaths for 36 cancers and all cancers combined in 2022.

	Incidence			Mortality		
Cancer site	Rank	New cases	% of all sites	Rank	Deaths	% of all sites
Lung	1	2,480,301	12.4	1	1,817,172	18.7
Female breast	2	2,308,897	11.6	4	665,684	6.9
Colorectum	3	1,926,118	9.6	2	903,859	9.3
Prostate	4	1,466,680	7.3	8	396,792	4.1

CA A Cancer J Clinicians, Volume: 74, Issue: 3, Pages: 229-263, First published: 04 April 2024, DOI: (10.3322/caac.21834)

At Delta Hospital

- **In 2024- more than 820 patients received radiotherapy including 2D, 3DCRT & IMRT/VMAT**

Year	Right Breast Patients	Left Breast Patients
2024	392	428

Radiotherapy Left Breast Cancer

Multimodal Treatment for Locally Advanced Breast Cancer (LABC)

📌 **Standard Treatment Approach:**

- Modified radical mastectomy followed by chemotherapy and radiotherapy.

📌 **Benefits of Post-Mastectomy Radiotherapy (PMRT):**

- **M Clarker et al. Lancet 2005:366(9503):2087-106**
  - Reduces **chest wall (CW) recurrence** by a factor of **3–4** and improves **overall survival** by **6%**.

Radiotherapy Left Breast Cancer

📌 **Radiation Therapy Techniques in Breast Cancer:**

- **3DCRT, IMRT, and VMAT** are commonly used approaches.

📌 **3DCRT: The Reference Technique**

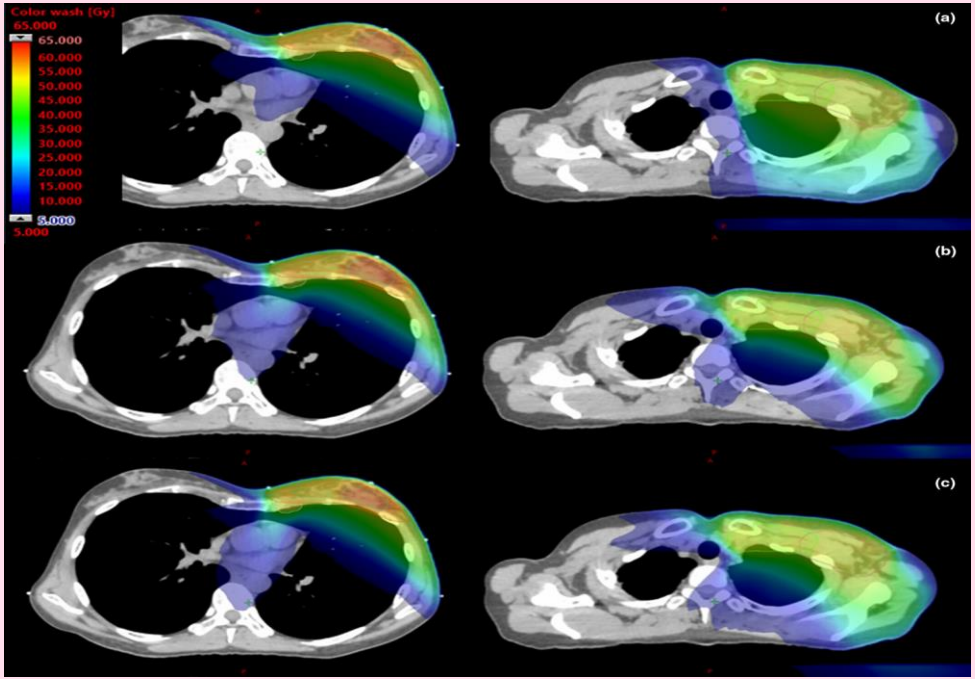
- ✅ **Widely available** and **cost-effective**.
- ❌ **Challenges:**
- Low conformity & homogeneity.
- Under-coverage at the **CW-SCL junction**.
- High-dose spillage outside the **Planning Target Volume (PTV)**.

Radiotherapy Left Breast Cancer

- **IMRT & VMAT help**
  - to reduce dose to the heart and IL
  - improving the PTV coverage, conformity and homogeneity
  - VMAT has the advantage of a faster treatment time.
- **However, VMAT in breast cancer**
  - induces a considerable increase in the volume of healthy tissue receiving low doses
  - thereby increasing the risk of secondary cancers

Why reconsider traditional VMAT?

- **Important to account for low-dose exposure to healthy tissue**
- **Byrne M et al. J Appl Clin Med Phys 2018; 19: 684–93.**
  - **The generation of low-dose baths specifically to the contralateral breast, lung and heart which exceed that of 3DCRT**
- **Ma et al. Sci Rep 2015; 5: 12274**
  - **VMAT was associated with an increase in mean heart dose and low-dose volume to the lung, compared with 3D-CRT, possibly explaining the higher use of tangential IMRT over VMAT**
- **Haciislamoglu et al. BJR 2019; 92: 20190317**
  - **An estimation of excess absolute risk (EAR) in terms of developing a secondary cancer and observed the volume of low dose (3 Gy and 5 Gy) to normal tissue was significantly higher with IMRT and VMAT than FiF**



J of Medical Radiation Sci, Volume: 69, Issue: 1, Pages: 85-97, First published: 12 August 2021, DOI: (10.1002/jmrs.534)

Solution – Hybrid VMAT

To improve outcomes, we implemented:

- **HYBRID VMAT** approach
- Combining VMAT with the **3D Field-in-Field (FiF) technique**
- Aiming to optimize target coverage while reducing unnecessary exposure to healthy tissue

Some Background on Hybird VMAT...

www.nature.com/scientificreports

scientific reports

OPEN

Hybrid VMAT-3DCRT as breast cancer treatment improvement tool

Cyril Voyant[1,2✉], Morgane Pinpin[2], Delphine Leschi[2], Séverine Prapant[2], Françoise Savigny[2] & Marie-Aimée Acquaviva[2]

Radiation therapy is an important tool in the treatment of breast cancer and can play a crucial role in improving patient outcomes. For breast cancer, if the technique has been for a long time the use of 3DCRT, clinicians have seen the management evolve greatly in recent years. Field-in-field and IMRT approaches and more recently dynamic arctherapy are increasingly available. All of these approaches are constantly trying to improve tumour coverage and to preserve organs at risk by minimising the doses delivered to them. If arctherapy allows a considerable reduction of high doses received by healthy tissues, no one can deny that it also leads to an increase of low doses in tissues that would not have received any with other techniques. We propose a hybrid approach combining the robustness of the 3DCRT approach and the high technicality and efficiency of arctherapy. Statistical tests (ANOVA, Wilcoxon, determination coefficient, ROC, etc.) allow us to draw conclusions about the possibility of using the hybrid approach in certain cases (right breast, BMI > 23, age > 48, target volume > 350 cc, etc.). Depending on the breast laterality and patients morphological characteristics, hybridization may prove to be a therapeutic tool of choice in the management of breast cancer in radiotherapy.

Medical Dosimetry 40 (2015) 262–267

ELSEVIER

Medical Dosimetry

journal homepage: www.meddos.org

Dosimetric comparison of hybrid volumetric-modulated arc therapy, volumetric-modulated arc therapy, and intensity-modulated radiation therapy for left-sided early breast cancer

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Physica Medica 52 (2018) 86–92

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Contents lists available at ScienceDirect

Physica Medica

journal homepage: www.elsevier.com/locate/ejmp

Original paper

Hybrid volumetric modulated arc therapy for chest wall irradiation: For a good plan, get the right mixture

Karunakaran Balaji[a,b,*], Poonam Yadav[c], Sitaraman BalajiSubramanian[a], Chandrasekaran Anu Radha[b], Velayudham Ramasubramanian[b]

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Background…

ROJ Radiation Oncology Journal

Original Article

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https://doi.org/10.3857/roj.2020.00619

Dosimetric comparative study of 3DCRT, IMRT, VMAT, Ecomp, and Hybrid techniques for breast radiation therapy

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[3]Princess Alexandra Hospital, Queensland, Australia

La radiologia medica
https://doi.org/10.1007/s11547-019-00994-1

MEDICAL PHYSICS

Hybrid volumetric modulated arc therapy for whole breast irradiation: a dosimetric comparison of different arc designs

Velayudham Ramasubramanian[1] · Karunakaran Balaji[1,2] · Sitaraman Balaji Subramanian[2] · Krishnamoorthi Sathiya[2] · Moorthi Thirunavukarasu[2] · Chandrasekaran Anu Radha[1]

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Advance Access Publication: 12 August 2020

Journal of Radiation Research
OXFORD

Hybrid volumetric-modulated arc therapy for postoperative breast cancer including regional lymph nodes: the advantage of dosimetric data and safety of toxicities

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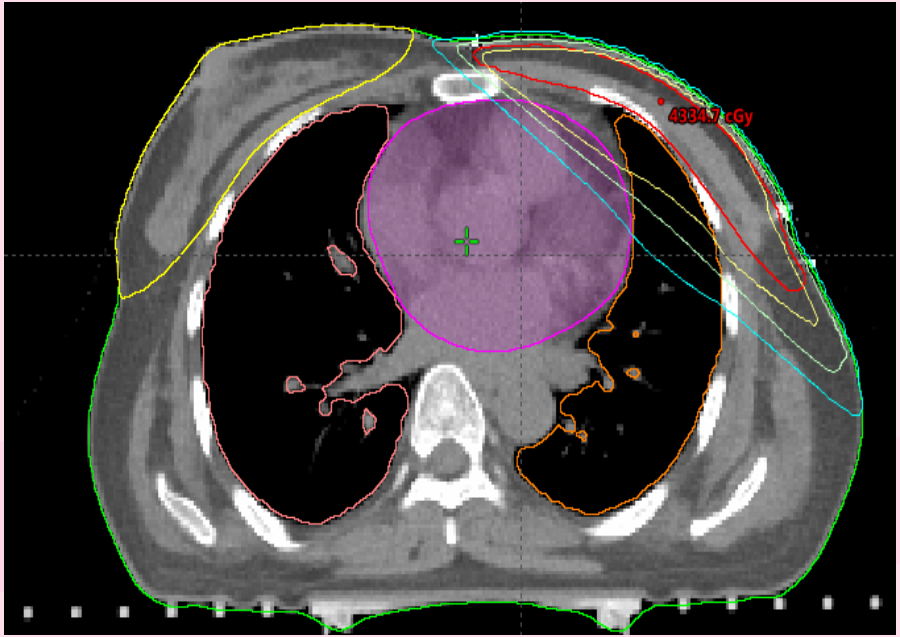
(Received 17 February 2020; revised 27 May 2020; editorial decision 29 June 2020)

Workflow and Implementation

- **Key Considerations:**
  - **10 Lt Breast Patients**
  - **Chest wall + Suprclav**
  - **Fraction size/dose**
    - **2.68 Gy/15 fractions**

- **We delineate**
  - **Heart**
  - **Ipsilateral Lung**
  - **Contralateral Lung**
  - **Contralateral Breast**
  - **Chestwall PTV volume**



Workflow and Implementation

❖ **Planning consideration:**

- Varian Eclipse Treatment Planning System
- True Beam Linear Accelerator
- 3DCRT
- VMAT
- Hybrid (3DCRT+VMAT)

For Each Patients we established

- 6 dosimetrics
- 3DCRT
- VMAT

Hybrid

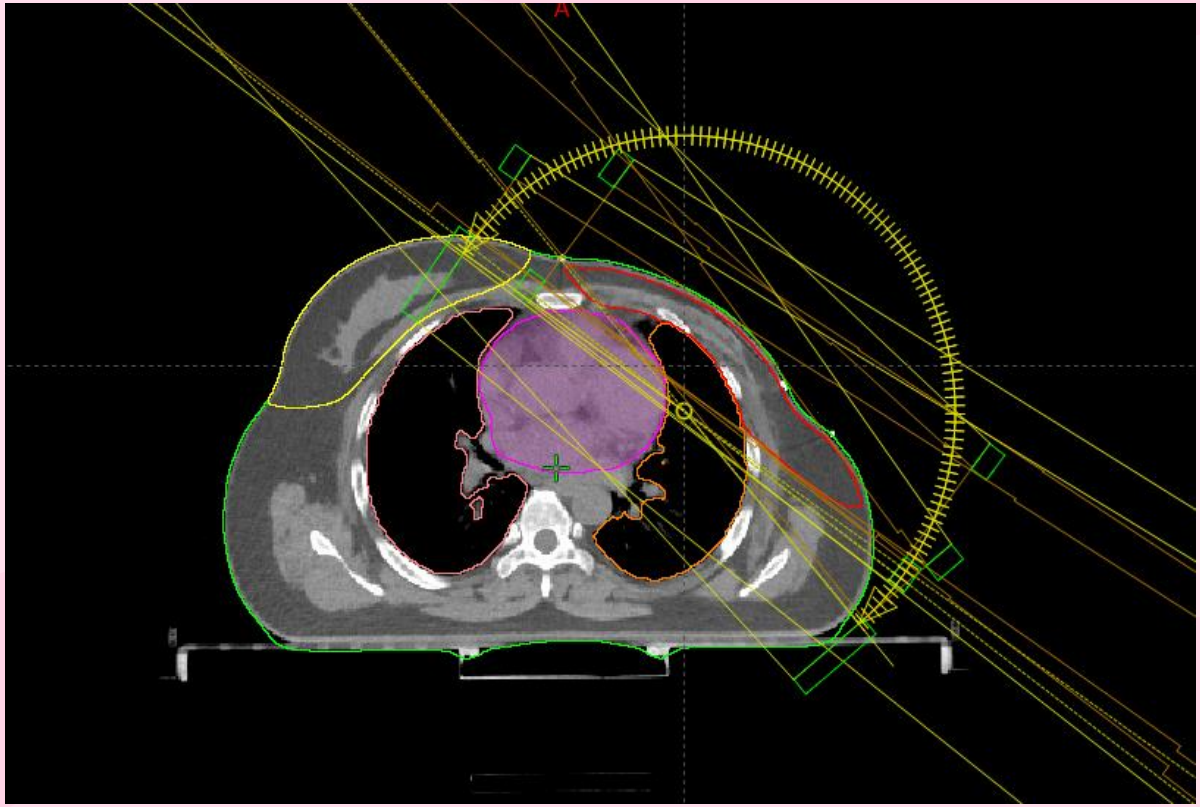
- 80% 3DCRT/20% VMAT
- 70% 3DCRT/30% VMAT
- 60% 3DCRT/40% VMAT
- 50% 3DCRT/ 50% VMAT

Treatment Planning

- Isocentre positioned between CW and SCL junction
- Same isocentre for VMAT, 3DCRT and hybrid
- Same Collimator angle (0°)
- Gantry angle selected based on PTV curvature

Method	Prescription	Beams	Nature	Gantry Angle	Rotation	Colli
3DCRT	CW+SCL	Med. Tangent	FiF/6X	305-310	n/a	0
		Lat. Tangent	FiF/6X	125-130	n/a	0
VMAT	CW+SCL	Arc 1	VMAT/6X	305-310	CW	0
		Arc 2	VMAT/6X	135-140	CCW	0
Hybrid	CW+SCL	Tangent+Arc	FiF+VMAT /6X	3D+VMAT	n/a & Arc	0

Treatment Planning…..



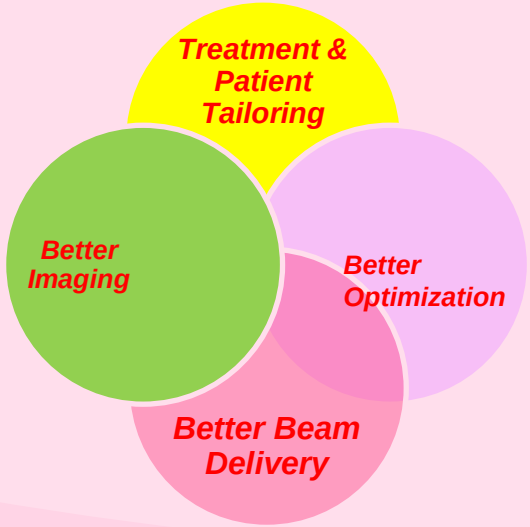
Planning Objectives

PTV/OARs	Dose Constraints
PTV	D95% ≥ 38.19 Gy D2% ≤ 44.22 Gy HI = 0 CI ≥ 0.80
Heart	V20Gy ≤ 5 % Mean ≤ 4 Gy
Ipsilateral Lung	V20Gy ≤ 15 % V10Gy ≤ 35 % V5Gy ≤ 50 % Mean ≤ 12 Gy
Contralateral Lung	Mean ≤ 3Gy
Contralateral Breast	Mean ≤ 3Gy

RADIATION THERAPY ONCOLOGY GROUP

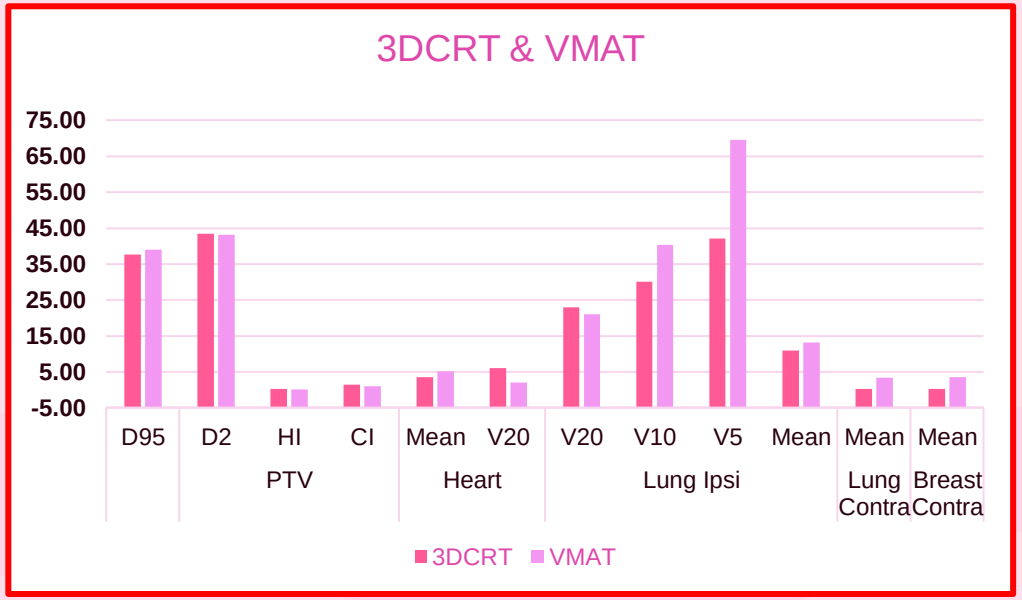
RTOG 1005

A PHASE III TRIAL OF ACCELERATED WHOLE BREAST IRRADIATION
WITH HYPOFRACTIONATION PLUS CONCURRENT BOOST
VERSUS STANDARD WHOLE BREAST IRRADIATION
PLUS SEQUENTIAL BOOST FOR EARLY-STAGE BREAST CANCER

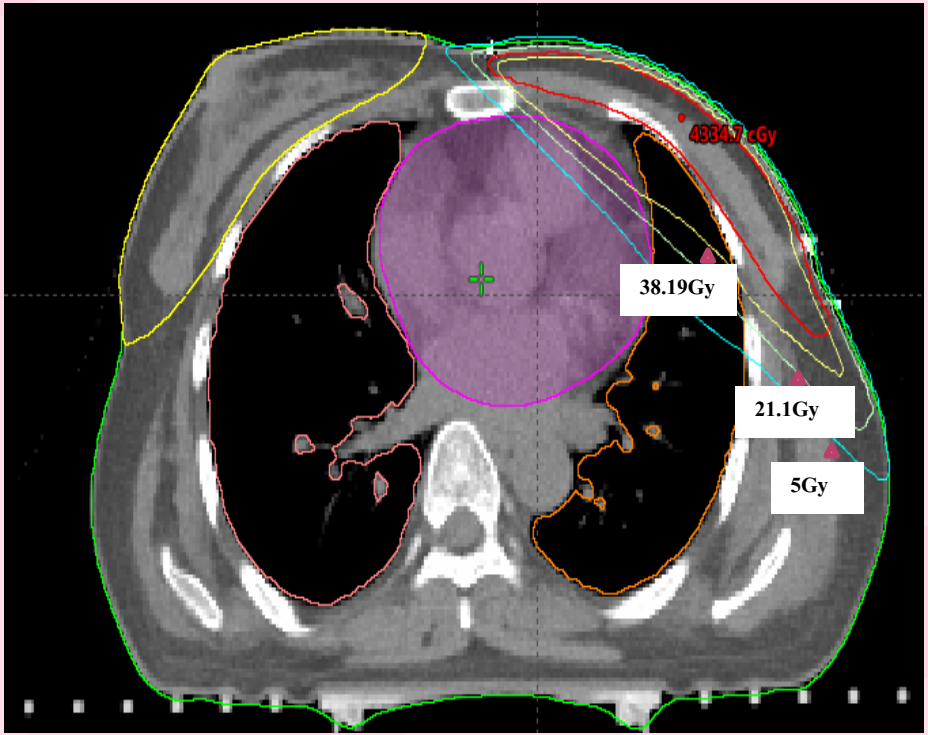


Comparison of 3DCRT & VMAT

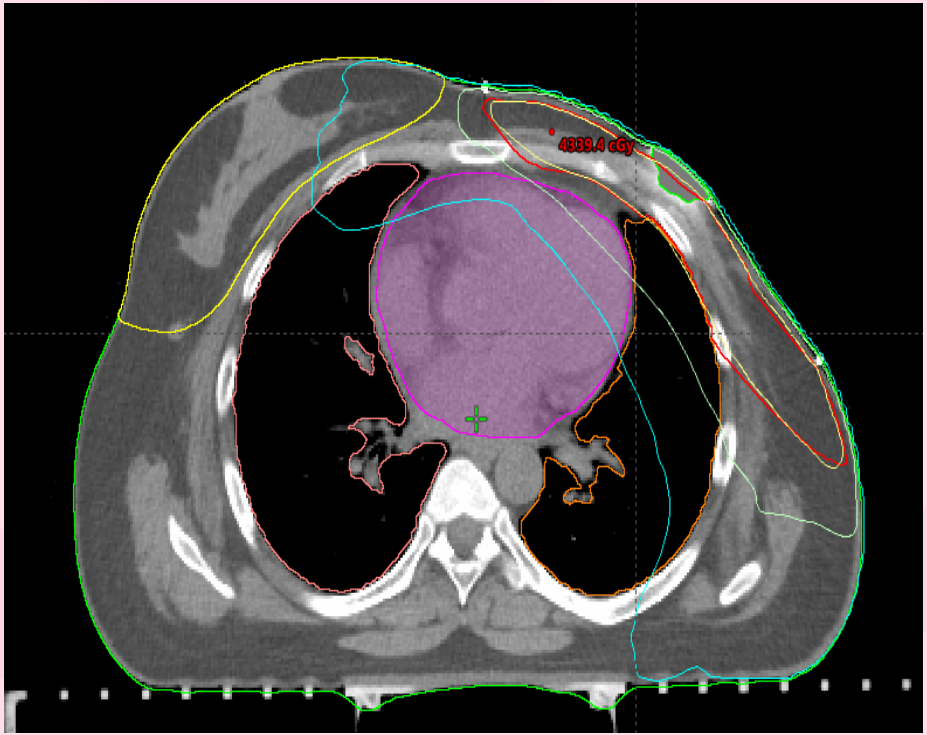
Parameter		3DCRT	VMAT
PTV	D95	37.70	39.00
	D2	43.50	43.20
	HI	0.20	0.13
	CI	1.50	1.04
Heart	Mean	3.50	5.10
	V20	6.00	2.00
Lung Ipsi	V20	23.00	21.00
	V10	30.10	40.30
	V5	42.10	69.5
	Mean	11.0	13.1
Lung Contra	Mean	0.20	3.40
Breast Contra	Mean	0.30	3.60



3CRT

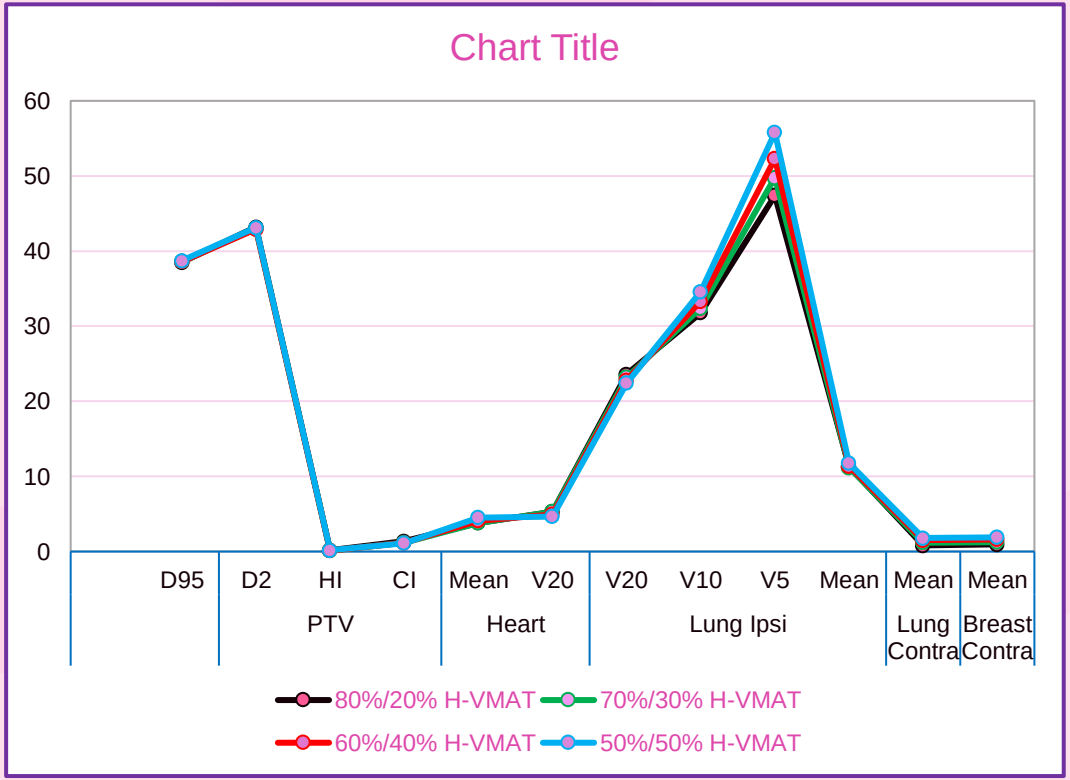


VMAT

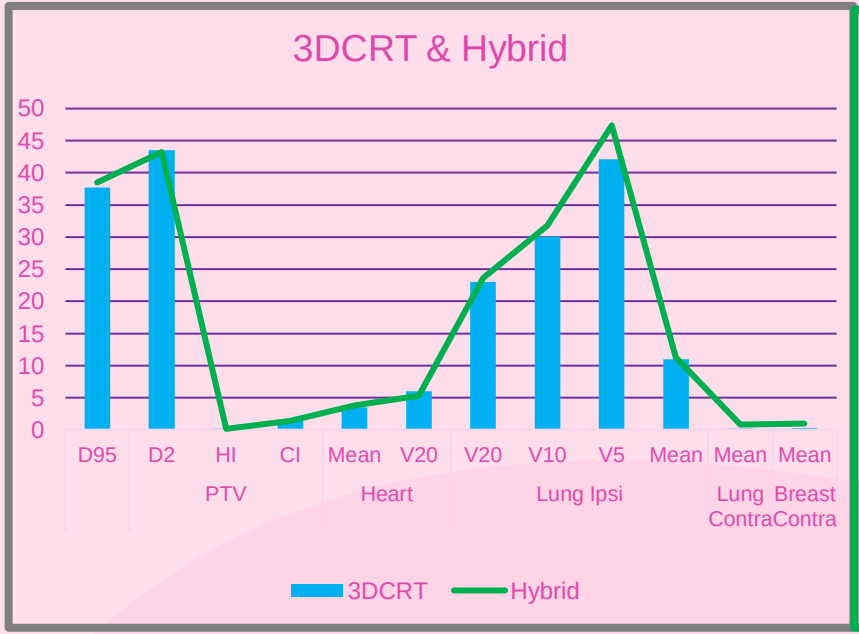


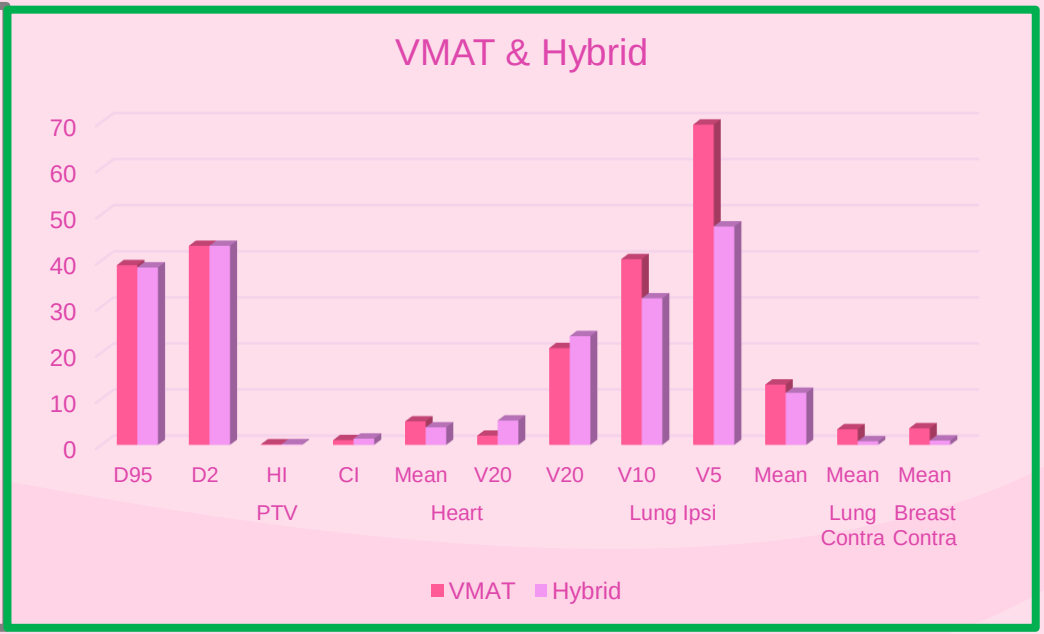
Different Proportion of Hybrid VMAT

Parameter		80%/20% H-VMAT	70%/30% H-VMAT	60%/40% H-VMAT	50%/50% H-VMAT
PTV	D95	38.50	38.60	38.60	38.70
	D2	43.20	43.0	42.9	43.10
	HI	0.15	0.13	0.13	0.14
	CI	1.37	1.20	1.15	1.13
Heart	Mean	3.80	3.83	4.10	4.53
	V20	5.30	5.31	4.96	4.65
Lung Ipsi	V20	23.60	23.2	22.8	22.4
	V10	31.8	32.40	33.30	34.6
	V5	47.4	49.8	52.30	55.8
	Mean	11.30	11.15	11.38	11.78
Lung Contra	Mean	0.8	1.20	1.50	1.80
Breast Contra	Mean	0.95	1.25	1.60	1.90

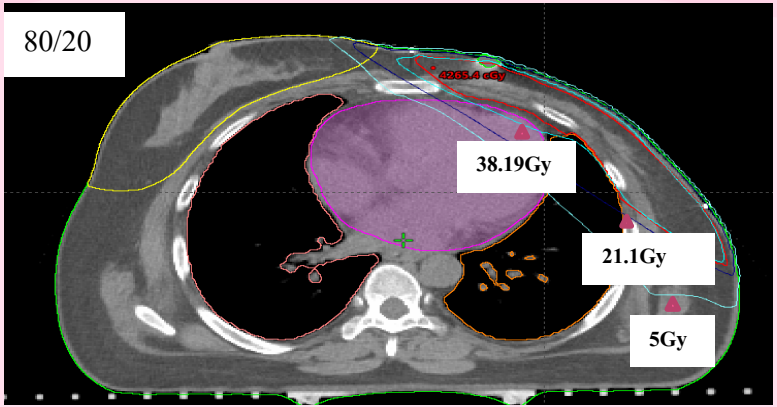


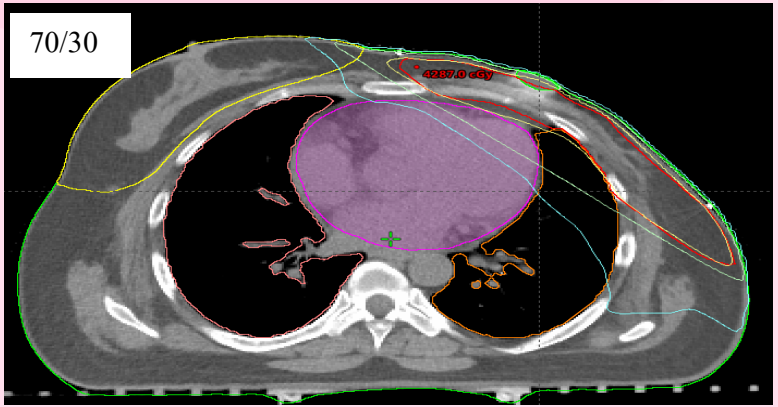
3DCRT, VMAT & Hybrid

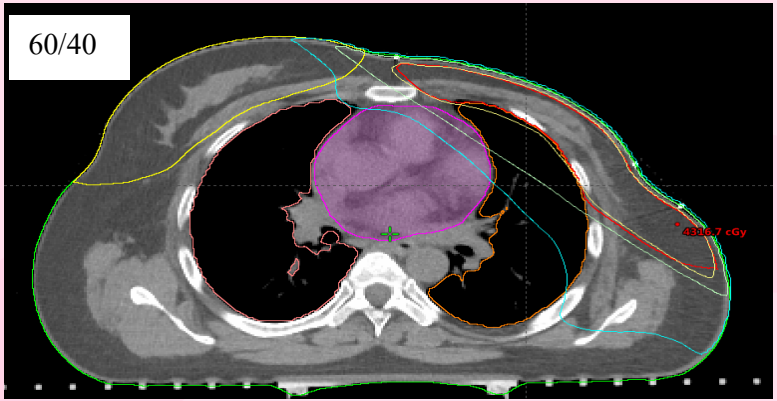


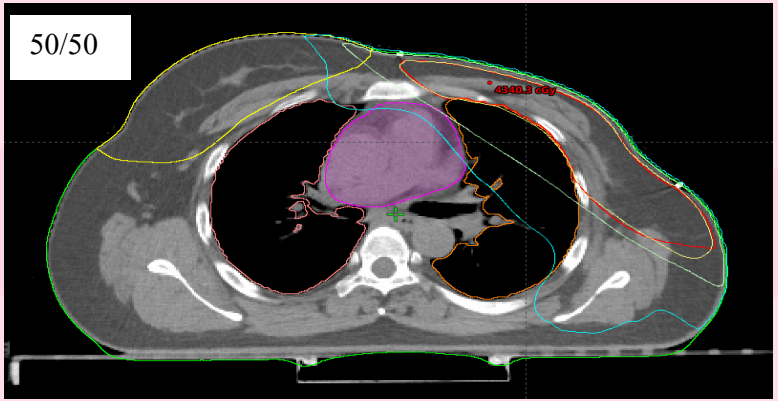


Comparative dose distribution of different dose weighting







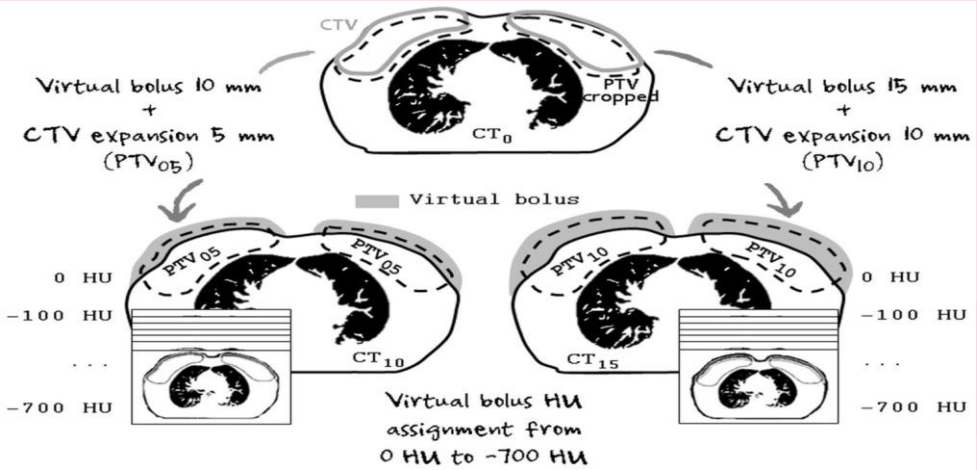


Summary of Clinical Studies on Whole-Breast Radiotherapy (WBRT) Using Hybrid Techniques.

Study	Dose Weighting	Findings
Abrose et al.(2021)	**60%–80% 3D + 20%–40% IMRT**	H-IMRT provided a good dose coverage and OAR protection.
Cilla et al.(2021)	80% 3D-CRT + 20% VMAT	H-VMAT resulted in superior target dose conformity and homogeneity compared to other techniques.
Cunningham et al.(2021)	70% 3DCRT + 30% IMRT	H-IMRT and IMPT provided better homogeneous dose distribution than IMRT.
Chen et al. (2020)	70% 3D CRT + 30% VMAT	H-VMAT advantages in the conformity index. H-VMAT plans better to the H-IMRT plans with regard to heart dose and treatment delivery time.
Balaji et al (2020)	70% 3D-CRT + 30% VMAT	H-IMRT and H-VMAT provide similar dosimetric results.
Chan et al.(2017)	80% 3D-CRT 20% IMRT	H-VMAT advantages in the conformity index. H-VMAT plans better to the H-IMRT plans with regard to heart dose and treatment delivery time.

Do we need Skin Flash?

- **Open fields typically contribute 70-80% of the total weight and include flash to compensate for positioning, breathing motion, and setup errors.**
- **Maintaining this ratio may eliminate the need for flash, but reducing it requires retaining flash.**



Physica Medica,Volume 63: P56-62July 2019; DOI: 10.1016/j.ejmp.2019.05.010

Summary

- A **70–80% dose weighting** from **3DCRT** and **20–30% from VMAT** was found to be optimal for the **H-VMAT technique**.
- If hybrid planning is the preferred approach for target volume coverage, **3DCRT for OAR sparing**.
- Lung CL and LungIL, there is an extremely **significant difference highlighting** the quality of the 3DCRT & VMAT.
- In this study, we realize that the doses to the **contralateral breast and lung are indeed low (Dmean <3 Gy)** but much higher than those observed with 3DCRT.

- It is important to mention that the increase of **low dose bath** will provide in principle an **increase in second cancer risk**, at different years post radiotherapy.

Thank You

IF I CAN DO CANCER I CAN DO ANYTHING