IMRT For Breast Cancer: To do or not to do?

Ashwini Budrukkar

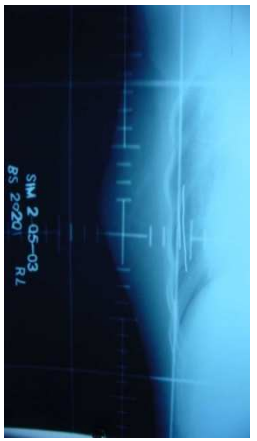
Professor, Department of Radiation Oncology,

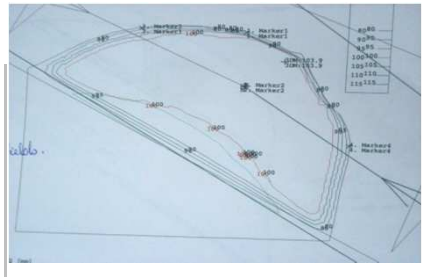
Tata Memorial Hospital

Standard Tangents

2D planning

- Contour taken at central axis and dose distribution evaluated





Advantages

Good technique, simple

Time tested

Reasonably good sparing of lungs and heart

Acute & Late Sequelae of Standard Tangents

ACUTE

- Skin toxicity in one third
- Infra-mammary fold
- Treatment break
- Quality of life
- Factors associated:
  - Large breast size
  - Hotspots (>2cm^3 of 107% of PD)

LATE

- Cosmetic outcome (25-40% experience change in breast appearance at one year depending upon breast size)
  - Breast shrinkage
  - Telangiectasia
  - Breast fibrosis
  - Breast edema
- Psychological morbidity

Modern RT Techniques

- Conventional tangents with simple or customized shielding
- Photon based
  - 3DCRT: wedges, MLCs for shielding heart, overdose volume
  - Forward plan IMRT
  - TomoTherapy
  - TopoTherapy (TomoDirect)
  - Arc therapy (VMAT)
  - Flattening filter free planning
  - Inverse plan IMRT
- Electron based
  - IMRT (prevents low dose exposure of C/L lung & breast)
  - Electronic compensation (lowest no of MUs & planning time)
- Proton IMRT

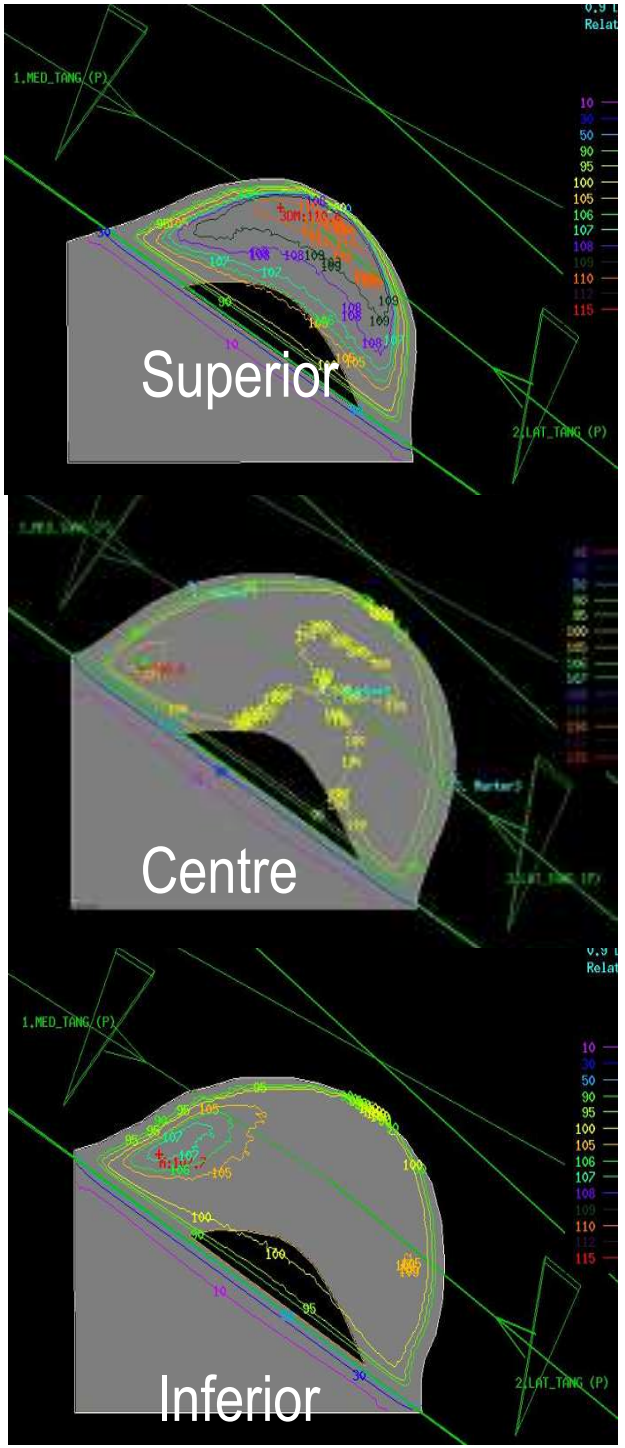
Medical Dosimetry, Vol. 34, No. 2, pp. 140-144, 2009

0958-3947/09/$–see front matter
doi:10.1016/j.meddos.2008.08.006

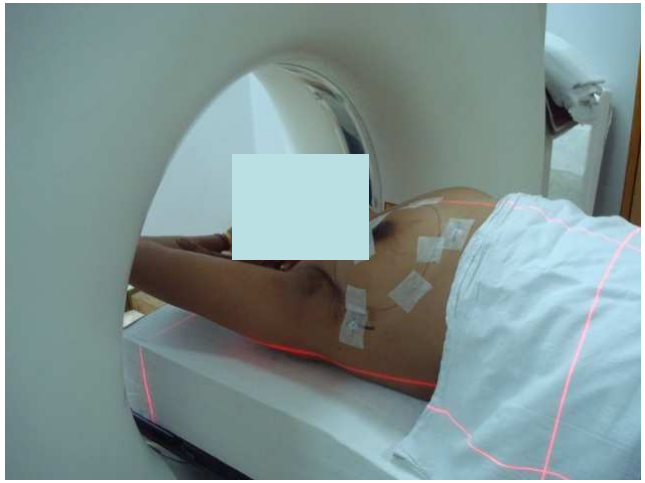
DO ALL PATIENTS OF BREAST CARCINOMA NEED 3-DIMENSIONAL CT-BASED PLANNING? A DOSIMETRIC STUDY COMPARING DIFFERENT BREAST SIZES

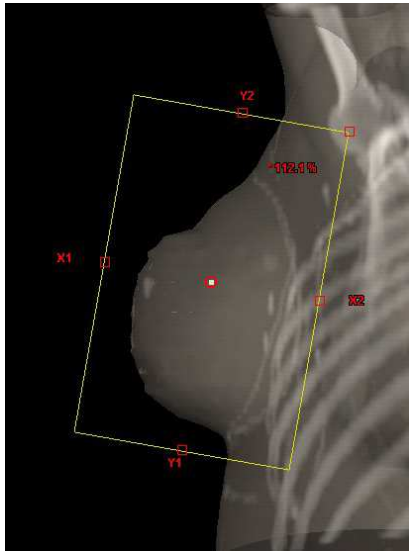
Munshi et al

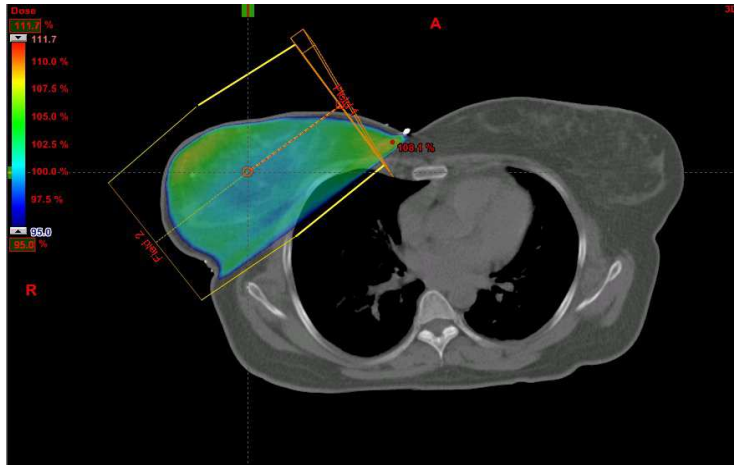
	Superior slice	Inferior slice
Large Breast	9%	15%
Medium Breast	8%	8%
Small Breast	5%	5%

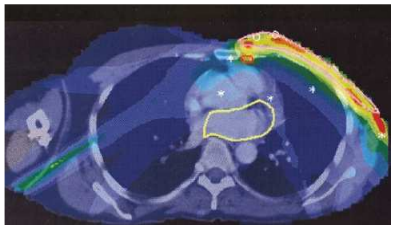


3 Dimensional planning



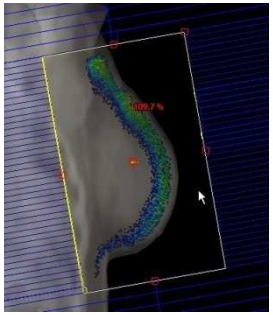
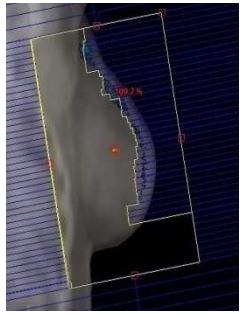
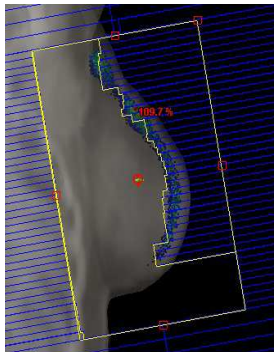
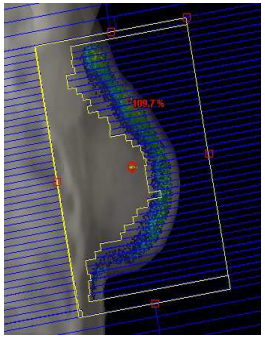
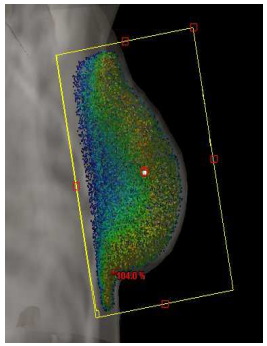
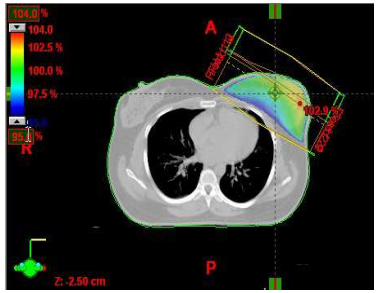






Forward planned IMRT

- Modified bi-tangential portals
- Use of multiple segments inside each tangential portal
- Homogenous dose distribution through out the breast
- Possible improvement in the cosmetic outcome

Randomized trial of IMRT vs Tangents

Canadian trial, Multicentre (N=331)

80% medium/large breasts, 50Gy/25#/5weeks±16Gy boost

Endpoint: Acute skin reaction, moist desquamation

	Tangents (161)	**IMRT (171)**	**p value**
Skin toxicity grade III and IV	36.0%	27.1%	0.06
Moist desquamation, all breast	47.8%	31.2%	0.002
Moist desquamation, infra mammary area	43.5%	26.5%	0.001

Pignol JP et al JCO 2008

Randomised trial of IMRT vs Tangents

Royal Marsden Hospital trial

306 women with high risk for developing reactions: median breast volume 1046 cc (50Gy/25# + 11.1Gy/5# electron boost)

Primary endpoint: Late, change in breast appearance

5 year late sequelae	**2D RT (156)**	**IMRT (150)**	**p value**
Photographic score at 5 yrs-	58%	40%	0.008
Induration-centre	32%	21%	0.02
Induration-inframammary fold	24%	17%	0.009
Induration-pectoral fold	29%	22%	0.006

Donovan E et al Radiother Oncol 2007 (82): 254–264

Randomised trial of IMRT vs Tangents

Cambridge University Hospital trial (N=815)

All breast sizes (40Gy/15# ± 9Gy/3# electron boost), mean breast volume 1300cc in randomized patients

Primary endpoint: Late, change in breast appearance

5 year Late sequelae	**2D RT (404)**	**IMRT (411)**	**p value**
Telangiectasis	24%	15%	0.031
Overall final cosmesis (good-moderate)	78%	88%	0.038

No difference seen on photographic assessment for breast shrinkage, breast edema, tumor bed induration, or pigmentation

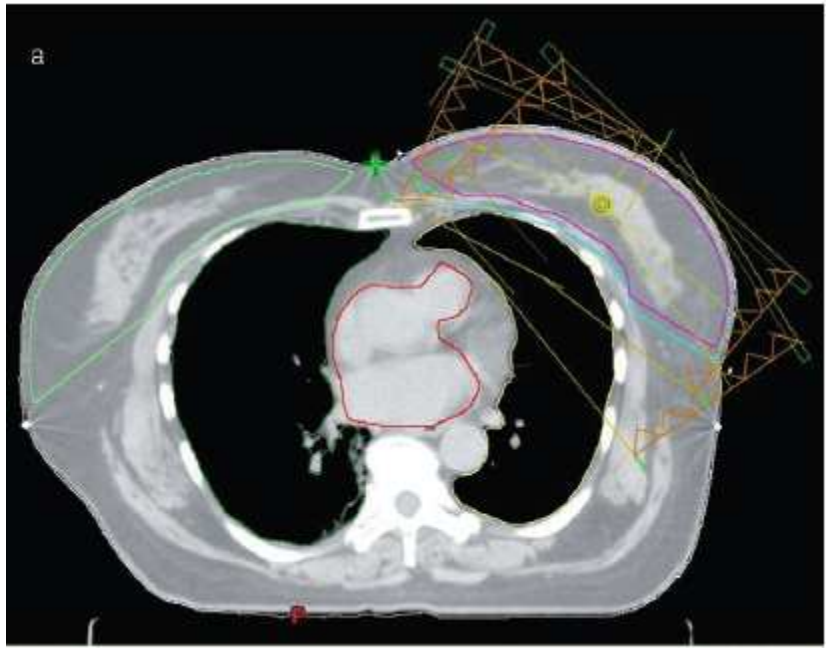
Mukesh et al JCO 2013, 31: 4488-95

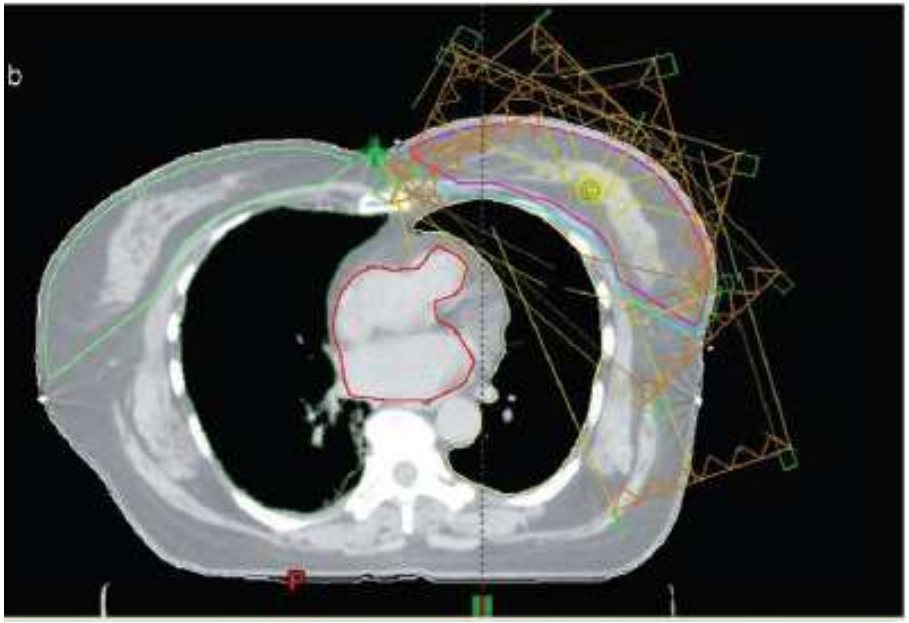
Large Phase II data: Fox Chase Cancer Centre

- Early Breast Cancer-Stage 0,I,II
- Study Period: 2003-2010
- N=936
- Technique: Open tangents+ Inverse planned tangents
- Median FU: 31 months (1-97 months)
- 5 year actuarial IBTR rates: 2%
- 5 year actuarial Locoreg rec rates: 2.4%
- Cosemesis: Excellent: 63%, Good: 33%
- Breast Volume> 900cc, boost dose>16Gy, boost volume >34cc: Impact on fair/poor cosmetic outcome

Keller L. IJROBP 2012

Inverse Plan IMRT

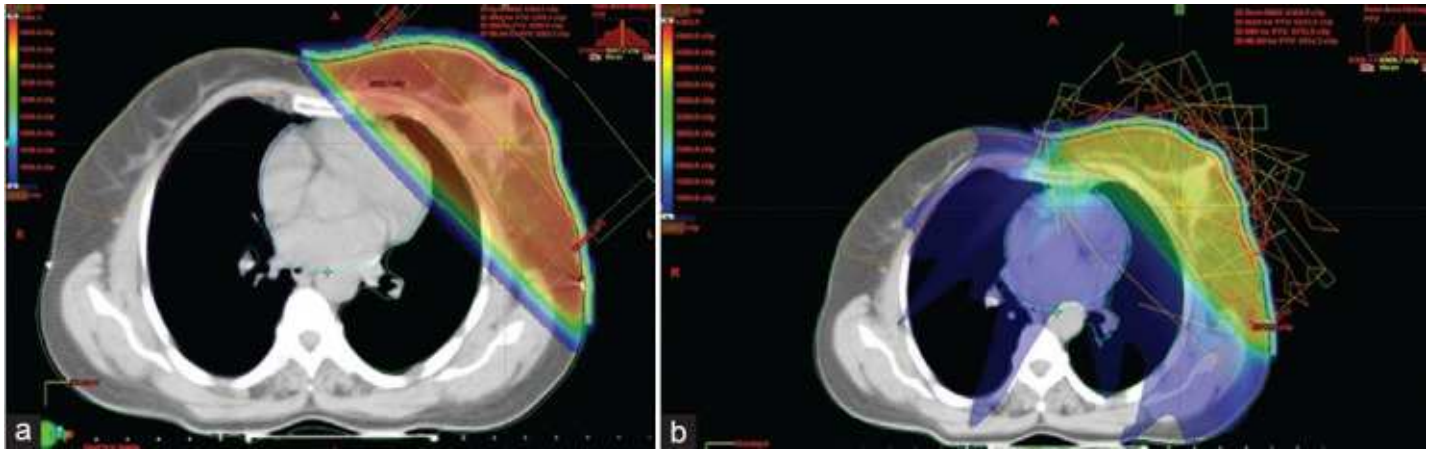




Increase in mean doses of ipsilateral lung, heart and opposite breast

Dosimetric Comparison of Inverse planned IMRT vs Forward planned IMRT

- 20 women with L sided breast cancer
- 10 post-mastectomy, 10 post BCT
- 3 Plans: Open fields, Inverse plan IMRT, Field in Field Forward plan IMRT



Forward Plan IMRT Inverse Plan IMRT

5 Gy volume

Al Rahbi JS. Journ Med Physc 2013

Standard Tangents: Late Sequelae

Oxford Overview - mortality without recurrence in Radiotherapy trials

	Events	O-E	Hazard Ratio	p
Circulatory disease	**1510**	**77.6**	**1.25 (0.06)**	**0.00003**
Heart disease	1106	60.7	1.27 (0.07)	0.0001
Stroke	345	9.1	1.12 (0.12)	NS
Pulmonary embolism	59	7.8	1.76 (0.36)	0.04
Other causes	**1455**	**6.4**	**1.02 (0.06)**	**NS**
Lung cancer	**156**	**21.7**	**1.78 (0.22)**	**0.0004**
Oesophagus cancer	**23**	**4.9**	**2.40 (0.68)**	**0.04**
Leukaemia	31	2.4	1.40 (0.45)	NS
Soft-tissue sarcoma	7	1.3	2.13 (1.14)	NS
Respiratory disease	241	-1.0	0.98 (0.13)	NS
Other known causes	997	-22.9	0.90 (0.06)	NS
Unspecified cause	**701**	**7.8**	**1.05 (0.08)**	**NS**
Total	**3666**	**91.8**	**1.12 (0.04)**	**0.001**

Low Dose Scatter: Does Matter

EBCTCG 2005

What is the Optimal Beam Arrangement for IMRT?

- TANGENTS!!!
- Less low dose: Lung, Heart, Contralateral Breast
- Adequate coverage of Target volume
- Early Breast Cancer women: Do survive long… to see the long tem effects of scatter dose

Practical Radiation Oncology (2014) 4, 349-355

www.practicalradonc.org

Special Article

Choosing Wisely: The American Society for Radiation Oncology's Top 5 list

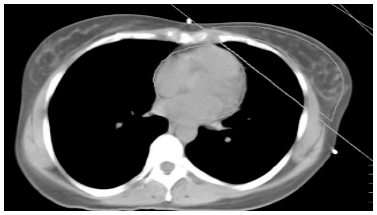
Carol Hahn MD [a,*,1], Brian Kavanagh MD, MPH [b,1], Ajay Bhatnagar MD, MBA [c], Geraldine Jacobson MD, MBA [d], Stephen Lutz MD [e], Caroline Patton MA [f], Louis Potters MD [g], Michael Steinberg MD [h]

[a]Department of Radiation Oncology, Duke University Medical Center, Durham, North Carolina

5. Don't routinely use intensity modulated radiation therapy (IMRT) to deliver whole-breast radiation therapy as part of breast conservation therapy.	• Clinical trials have suggested lower rates of skin toxicity after using modern 3D conformal techniques relative to older methods of 2D planning. • In these trials, the term "IMRT" has generally been applied to describe methods that are more accurately defined as field-in-field 3D conformal radiation therapy. • While IMRT may be of benefit in select cases where the anatomy is unusual, its routine use has not been demonstrated to provide significant clinical advantage.[28,31-33]

2D, 2-dimensional; 3D, 3-dimensional.

How to Spare Heart?
Deep Inspiratory Breath Hold



- stage I and II left sided breast cancer and treatment delivered with step and shoot IMRT.

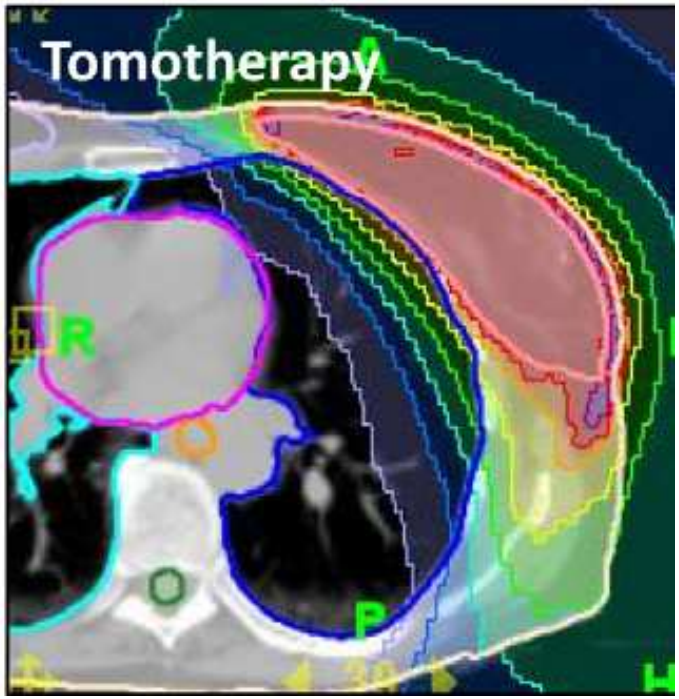
	Heart V30 FB (%)	Heart V30 BH (%)	Maximum Heart Distance (cm) FB	Maximum Heart distance (cm) BH
1	3.6%	0%	1.7	0
2	3.3%	0.6%	1.4	0.7
3	2.3%	0.1%	1.2	0.3
4	5.9%	0.1%	1.8	0.5
5	9.7%	0.1%	2.1	0.2

Remouchamps VM et al, IJROBP. 2003;56(3):704-15

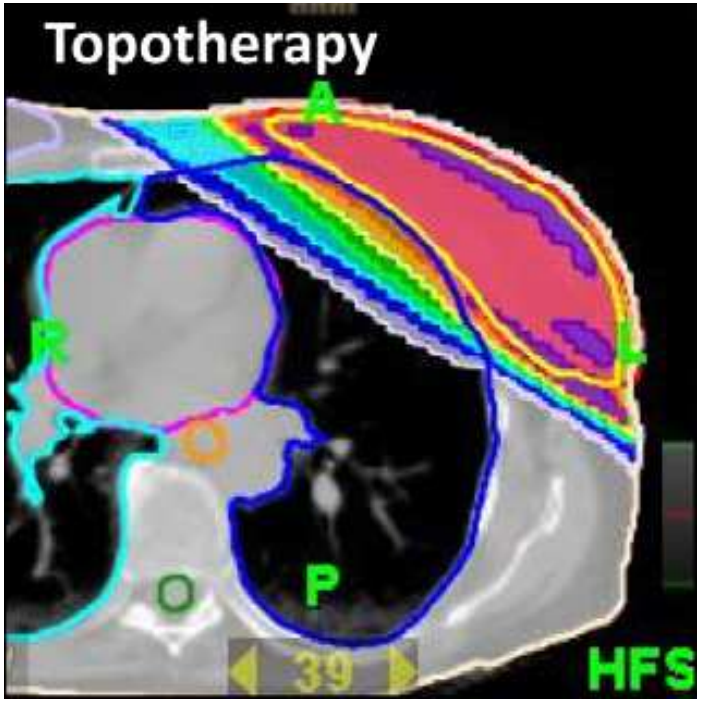
TomoTherapy (TT) Hi-ART System

Integrated Image Guidance using MVCT

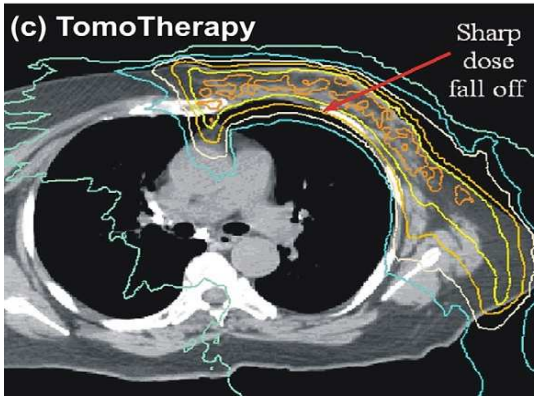
HELICAL MODE (HT)



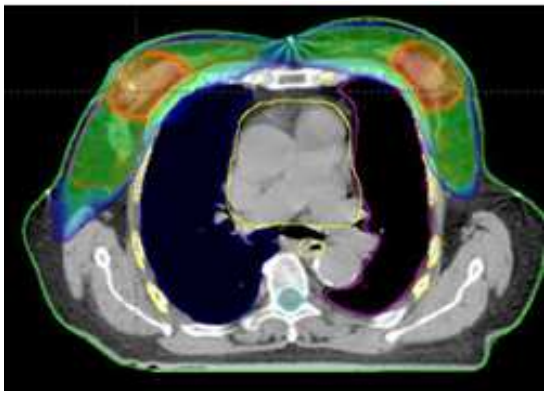
STATIC MODE /TomoDirect (TOPOTHERAPY)



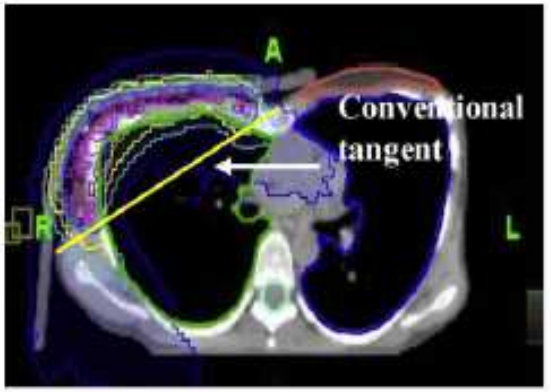
Potential Indications for TT



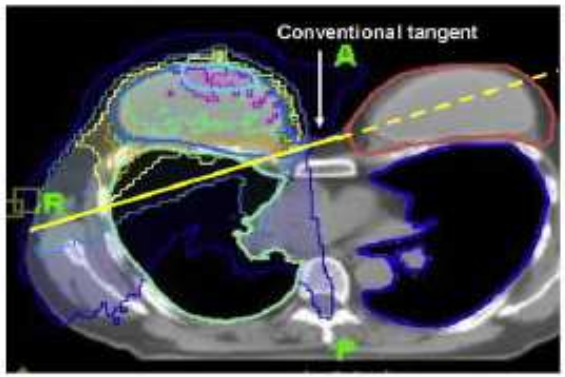
Loco-regional RT



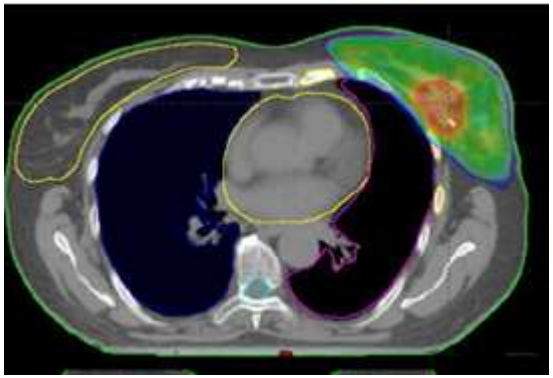
Bilateral breast



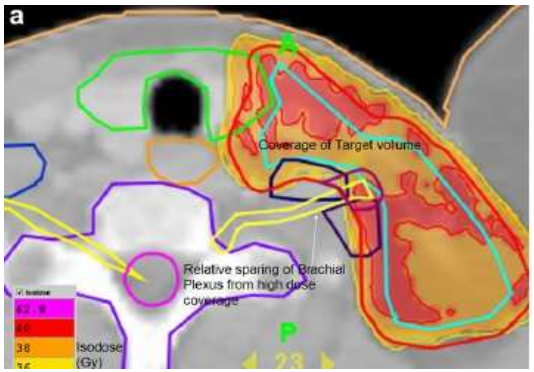
Unfavorable anatomy



Breast Implants



Hypo-fractionation with SIB



Brachial plexus sparing with dose escalation

VMAT

- Novel extension of IMRT
- Optimized three-dimensional (3D) dose distribution may be delivered in a single gantry rotation
- Reduction in treatment MUs (30%) and delivery time (55%) due to high dose rates (as compared to cIMRT)
- Arc treatment: Larger low dose scatter-lungs, heart
- Dosimetric advantages of VMAT not confirmed for patients requiring adjuvant RT to breast only (Badakhshi et al, BJR 2013)

HYPOFRACTIONATION+SIB: PHASE I-II DATA (LINAC based techniques)

Author	N	FU	WB_dose	Boost_dose	Tehcnique	Dermatitis Grade 3/4	Local recurrence
Freedman	75	69 m	2.25 Gy x 20 = 45 Gy	2.8 Gy x 20 = 56 Gy	IMRT+electron boost	None	2.7%
Cante	463	60 m	2.25 Gy x 20 = 45 Gy	2.50 Gy x 20 = 50 Gy	3DCRT+6MV photon enface	2%	0
Corvo	377	33 m	2.3 Gy x 20 = 46 Gy	3.5 Gy x 5 = 52 Gy (weekly)	3DCRT for both	3%	0
Morganti	332	31 m	2.5 Gy x 16 = 40 Gy 2 Gy x 25 = 50 Gy	2.75 Gy x 16 = 44 Gy 2.4 Gy x 25 = 60 Gy	IMRT+electron boost	1% vs. 3%	0
Teh	15	12 m	2.65 Gy 16 = 42.2 Gy	3.28 Gy 16 = 52.48 Gy	IMRT+3DCRT boost	6.7%	0
Formenti	91	12 m	2.7 Gy 15 = 40.5 Gy	3.2 Gy 15 = 48 Gy	IMRT for both	0.9%	0
Chadha	50	NR	2.7 Gy x 15 = 40.5 Gy	3.0 Gy x 15 = 45 Gy	IMRT+3DCRT boost	None	NR

Hypofractionation+SIB: Ongoing Phase III IMRT trials

Trial	Endpoint	Accrual	Concurrent boost arm	
			PTVwb	PTVboost
RTOG1005	Local recurrence	2300	40 (2.67 Gy x 15 F)	48 (3.2 Gy x 15 F)
IMPORT HIGH	Palpable induration	820	I: 36 (2.3 x 15 F) II: 36 (2.3 x 15 F)	48 (3.2 Gy x 15 F) 53 (3.53 x 15 F)
IMRT MC2	Breast appearance	600	50.4 (1.8 Gy x 28 F)	64.4 (2.3 x 28 F)

IMRT for breast cancer: To do or not to do?

- Small size breast:Not to do IMRT
- Bi-tangential portals: Best beam arrangement
- 3D planning standard in modern era
- However may not be necessary in small and medium size breast
- Large breast > 1000cc IMRT may be considered
- In case IMRT is needed: Forward planned IMRT
- Forward planned IMRT: Better in terms of acute and late effects as compared to standard tangents
- Cardiac sparing is extremely important
- respiratory gating, image guidance are important in such situations

Acknowledgements

- Rakesh Jalali
- Rima Pathak
- Tabassum Wadasadawala