External Beam APBI Techniques

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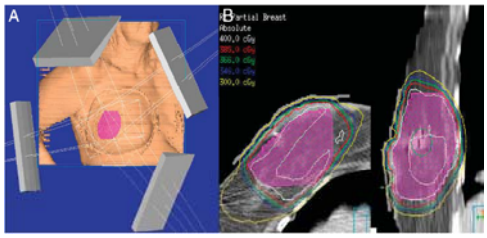
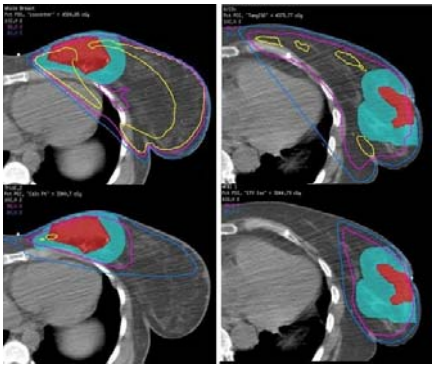


3D conformal external beam techniques: rapidly growing in popularity and application in the U.S.

2 fractions per day for 5 days

External beam
- Advantages -

- Non-invasive
- Delivers homogeneous dose with decreased procedural trauma to the breast
- Readily implemented in most radiotherapy clinics. Requires little or no additional capital expense
- Avoids "authorized user" responsibilities associated with HDR brachytherapy, i.e., each fraction does not require physical presence of MD
- Performed in the post-operative setting with margin and nodal status known

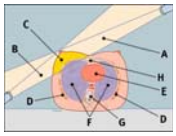


External Beam
- Disadvantages -

- Target volume sometimes difficult to delineate accurately
- Must account for set-up uncertainty and respiratory motion – adds significantly to PTV
- Due to entry and exit doses, generally associated with large volume of tissue exposed to radiation
- Generally limited to relatively small target volumes and medium-to-large size breasts
- Virtually no data available as to intermediate-to-long term effects

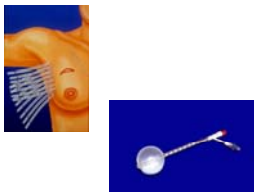
NSABP B39/RTOG 0413

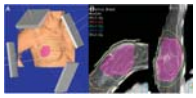
Accrual goal: 3000+ patients



Conventional whole breast radiotherapy

vs.





APBI: Three techniques allowed

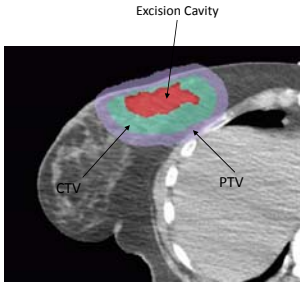
Study Goals:

- Establish equivalency of local control and overall survival of APBI to WBRT.
- Establish equivalency in cosmetic outcome between the two approaches.
- Analyze potential differences in fatigue, treatment related symptoms and convenience of care between APBI and WBRT patients.

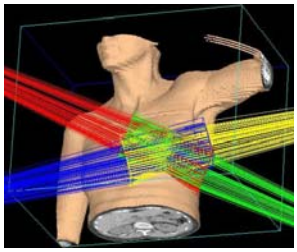
3D-CRT Planning Procedure:

- CT simulation performed in the supine position on a breast board.
- Radiopaque markers placed at midline, mid-axillary line, 1 cm below the infra-mammary fold, and at the level of the head of the clavicle to define the breast tissue.
- CT data transferred to the treatment planning workstation where excision cavity is delineated by the physician.

- The treatment isocenter placed in or near the excision cavity
- Excision cavity grown by ~1.5 cm to create the Clinical Target Volume (CTV).
- CTV grown by 1 cm to create the Planning Target Volume (PTV).



- Configurations consisting of 4-5 convergent non-coplanar tangential beams employed with the goal of minimizing treatment to surrounding normal tissues.
- Beam apertures generated from PTV.



3D-CRT Dose Limits:

- Uninvolved ipsilateral breast:
  - < 60% of whole breast should receive ≥ 50% of dose
  - < 35% of whole breast should receive ≥ prescribed dose
- Contralateral breast
  - should receive > 3% of prescribed dose
- Ipsilateral Lung
  - < 15% can receive 30% of dose
- Contralateral Lung
  - < 15% can receive 5% of dose

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3D-CRT Dose Limits:

- Heart
  - for right-sided lesions, < 5% of heart should receive 5% of dose
  - for left-sided lesions, < 40% of the heart should receive more than 5% of dose
- Thyroid
  - max point dose = 3% of prescribed dose

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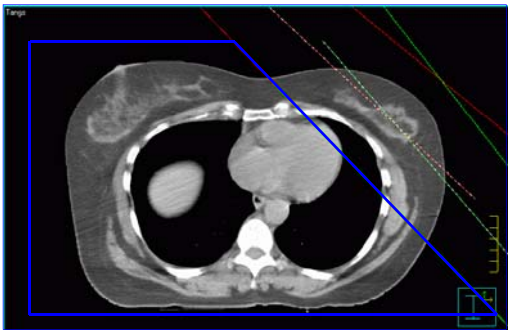
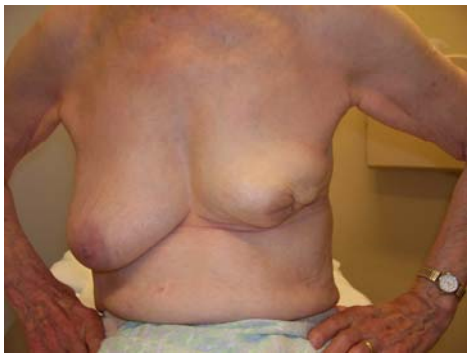
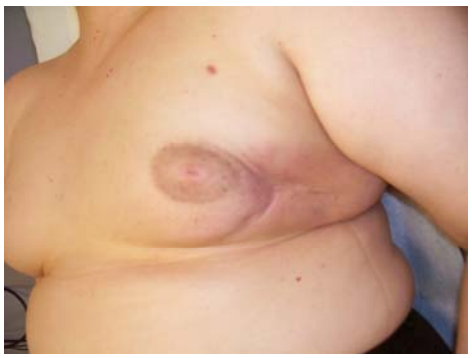
Whole Breast Contouring:



Grade 3 Fibrosis at 2 year follow up



Grade 3 Fibrosis at 1 year follow up



Univariate Analysis – Late Fibrosis

Table 3. Univariate Analysis: Late Subcutaneous Fibrosis (Grade 2-4)

Variable	Odds Ratio (OR)	p Value
PTV_Eval	1.1 (0.9 - 1.3)*	0.26
WBV	1.0 (0.9 - 1.1)**	0.85
PTV_Eval:WBV ratio	3.8 (0.8 - 18.3)†	0.10
V_5:WBV ratio	3.5 (1.1 - 11.1)†	0.03
V_{20}:WBV ratio	3.1 (1.1 - 9.0)†	0.04
V_{50}:WBV ratio	3.1 (1.0 - 9.8)†	0.06
V_{80}:WBV ratio	2.9 (0.9 - 9.9)†	0.09
V_{100}:WBV ratio	2.0 (0.6 – 7.0)†	0.28
DHI	0.9 (0.4 - 2.3)‡	0.85
Dmax	1.8 (1.1 - 2.1)§	<0.05

* OR for incremental increase in volume of 50 cc. ** OR for incremental increase in volume of 100 cc. ‡ OR for incremental increase in ratio of 0.05. † OR for incremental increase in ratio of 0.2. § OR for incremental increase in dose of 100

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Univariate Analysis – Cosmesis

Table 4. Univariate Analysis: Fair/Poor Cosmesis

Variable	Odds Ratio (OR)	p Value
PTV_Eval	1.1 (0.9 - 1.4) *	0.19
WBV	1.0 (0.9 - 1.1) **	0.62
PTV_Eval:WBV ratio	3.0 (1.2 - 7.6) †	0.02
V_5:WBV ratio	3.5 (1.0 - 12.2) †	0.05
V_{20}:WBV ratio	3.6 (1.1 - 12.1) †	0.04
V_{50}:WBV ratio	2.5 (0.8 - 8.5) †	0.13
V_{80}:WBV ratio	2.2 (0.6 - 7.9) †	0.24
V_{100}:WBV ratio	1.24 (0.3 - 4.9) †	0.76
DHI	1.1 (0.4 - 3.1) ‡	0.93
Dmax	1.4 (0.8 - 2.5) §	0.20
Path Vol	1.5 (1.1 - 2.1) *	0.01
SQ Fibrosis (Grade 2-4)	16.0 (3.4 - 75.3)	<0.001

* OR for incremental increase in volume of 50 cc. ** OR for incremental increase in volume of 100 cc. † OR for incremental increase in ratio of 0.2. ‡ OR for incremental increase in ratio of 0.05. § OR for incremental increase in dose of 100 cGy.

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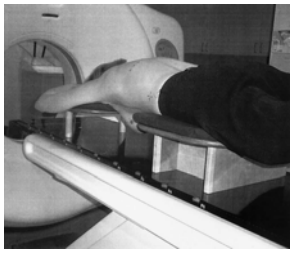
Recommended Parameters

- PTV_Eval (cc)
  - < 400cc
- PTV_Eval and V100 (% volume of whole breast)
  - <18-20%
- V50 (1925 cGy)
  - <40%
- V5 (192.5 cGy)
  - <70%
- No Grade 3 or great Toxicity seen in our series if these parameters were met.

NYU Technique

- Mini-tangents
- 30 Gy in 6 Gy fx to 95% IDL
  - M W F M W



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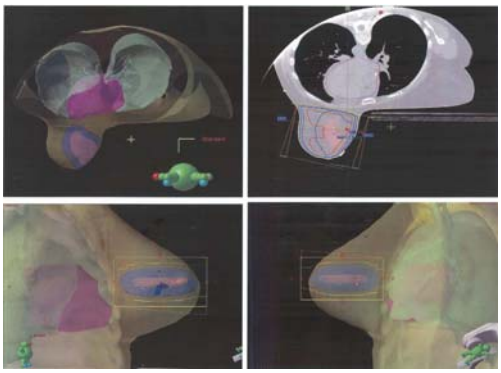
NYU Technique



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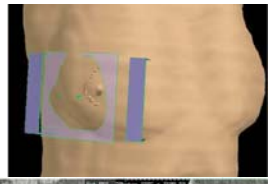
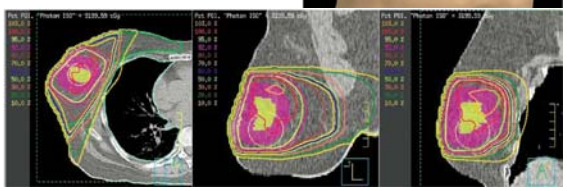
MGH Technique

- Mini-tangents
- En face electron beam
- 32 Gy in 4 Gy fx BID





Taghian et al. IJORBP 2006

The cost of APBI vs. WBRT

Suh et al. Int J Radiat Oncol Biol Phys 2005;62:790-796

Breast treatment	**Society's cost**
WBRT + boost	$10,900
WBRT	$8,500
WBRT accel course	$6,100
WBRT (IMRT)	$19,300
APBI (mammosite)	$18,300
APBI (interst. Catheters)	$17,300
APBI (3D-CRT)	$7,700
APBI (IMRT)	$9,700

Conclusions

- External beam APBI offers a non-invasive option for breast cancer patients appropriate for APBI treatment.
- External beam APBI provides a more homogeneous dose to the target volume than any of the other APBI modalities.
- However, more data needs to be collected to aid in determining safe dose volume constraints.