

**Accelerated Partial Breast Intensity  
Modulated Radiation Therapy (APB-IMRT)  
results in improved dose distribution when  
compared to 3D treatment planning  
techniques.**

Rusthoven K, Carter DL, Howell K, Kercher J, Sandoval  
A, Henkenberns P, Hunter K, Leonard CE

Denver, Colorado



**Purpose:** The RTOG 0413/NSABP B-39 trial is underway for patients with early stage disease comparing partial to whole breast radiotherapy. In this trial, three dimensional radiotherapy (3DRT) is the option being evaluated for external beam radiotherapy. IMRT has been shown in multiple disease sites to improve normal tissue sparing and radiation dose distribution. The present study compares dose distribution and normal tissue sparing using 3DRT versus IMRT.

**Materials/Methods:** 63 patients with T1N0 breast cancer were treated on a phase II prospective APB-IMRT protocol at two facilities between 4/2004 and 1/2006. All IMRT planning was done by one of two dosimetrists, and approved by one of two radiation oncologists. These cases were subsequently replanned using 3DRT techniques in order to compare the dose distribution patterns of 3DRT vs. IMRT. In all plans, the following structures were contoured: GTV, CTV, PTV, external, ipsilateral breast (IB), ipsilateral breast excluding PTV (IB-PTV), contralateral breast (CB), heart, ipsilateral lung (lung). Of the 63 cases, 7 were excluded from the current analysis due to inability to contour all evaluated structures. Thus, 56 patients had both IMRT and 3D plans available for comparison.

**Results:** The average PTV/IB ratio was 24% (range 7-58%). The current analysis showed a statistically significant reduction in the dose delivered to the ipsilateral breast (IB) and the uninvolved ipsilateral breast (IB-PTV) favoring IMRT. The volume of IB receiving 25% (V25), 50% (V50), 75% (V75) and 100% (V100) of the prescribed dose was 4.0%, 5.0%, 5.5% and 10.5% less with IMRT than with 3D ( $p < 0.01$ ). In these 224 individual endpoints (56 patients \* 4 IB endpoints), the dose to the IB was less in 89.7% involving IMRT vs. 3D. Similarly, the V25, V50, V75, and V100 to the IB-PTV was 5.2%, 6.5%, 7.1% and 5.4% less with IMRT ( $p < 0.01$ ) and the dose was less with IMRT in 93.3% of these 224 endpoints. In the subset of patients whose PTV to IB ratio was greater than 25%, and in patients with contoured breast volume less than 750cc, the dose reduction to normal breast was further improved. Dose delivery to target was similar with both modalities. The proportion of the GTV receiving 95% of the prescribed dose (V95) was 0.2% higher with IMRT (ns,  $p = 0.32$ ) and the V95 for the CTV was 0.1% higher with 3D conformal (ns,  $p = 0.60$ ). The V95 for the PTV was higher in the 3D conformal plans compared to IMRT (7.27%,  $p < 0.01$ ). The percentage of heart tissue receiving 5 Gy ( $p < 0.05$ ) and the percentage of lung tissue receiving 20 Gy ( $p < 0.01$ ) was small with both techniques, but also improved with IMRT.

**Conclusions:** In T1N0 patients treated with external beam partial breast radiotherapy, APB-IMRT improves normal tissue sparing in the ipsilateral breast compared to 3D Conformal, without compromising dose delivery to the GTV and CTV.

# Introduction

- **Randomized studies show equal 20 year OS & DFS for breast conservation therapy (BCT) vs mastectomy (1-4).**
- **Despite well established efficacy, only 10-40% of patients who qualify for BCT are treated in this manner (5). APBI offers shorter course and avoids delay of RT after chemotherapy.**

# Introduction

- **The feasibility of 3D conformal RT (3D-RT) has been demonstrated in phase I/II clinical trials (6-7).**
- **NSABP B39/ RTOG 0413 Phase III trial prospectively compares partial breast versus whole breast RT.**
- **3D-RT is the fastest accruing subset of the experimental arm.**

# Introduction

- **APB-IMRT potentially offers further improvement in normal tissue sparing through improved conformality and inverse planning.**
- **If IMRT planning conferred a significant reduction in uninvolved breast irradiation, then a reduction in the incidence of late toxicity and poor cosmetic outcomes may be expected.**

# Methods: Protocol

- **Phase II prospective APB-IMRT protocol with IRB oversight**
- **63 patients consecutive patients**
- **April 2004 - January 2006**
- **2 facilities (Littleton RMCC and SRMC)**
- **2 radiation oncologists (CL and DC)**
- **All patients treated with APB-IMRT**
- **Treatment planning systems Eclipse (RMCC) and ADAC (SRMC)**

# Methods: Eligibility

- **Tis or T1 N0 M0 breast cancer**
- **$\geq 40$  years of age**
- **negative surgical margins ( $\geq 2$  mm)**
- **All 63 IMRT plans were retrospectively replanned with 3D-RT**
- **7 of 63 cases were ineligible for analysis because of inability to contour all of the evaluated structures.**
- **Thus, 56 patients had both IMRT and 3D-RT plans completed for comparison**

# Methods: Volumes

- **Contoured target volumes**
  - GTV
  - CTV (GTV + 1 cm)
  - PTV (CTV + 1 cm)
  - skin and air removed from target
- **Normal volumes**
  - Ipsilateral breast (IB)
  - Ipsilateral breast excluding PTV (IB-PTV)
  - Contralateral breast (CB)
  - Ipsilateral lung (lung)
  - Heart

# Methods: Dosimetry

- All treated in 10 fractions BID over 5 consecutive days
- The first 8 patients were treated to 34 Gy
- The remaining 48 were treated to 38.5 Gy
- Dose volume histograms (DVH) were obtained for all contoured volumes for comparison

# Methods: Comparisons

- **Target volumes (GTV, CTV, PTV), compared:**
  - V95, V100
- **IB and IB-PTV**
  - V25, V50, V75, V100
- **CB, IL, and Heart**
  - Ranging from V3 to V50

**Note: V95 = % volume receiving at least 95 % of prescribed dose.**

# Results: Target Volumes

## Table 1: 3DRT –vs- IMRT Dose to Target

	Mean volume	3D-RT	IMRT	Δ	T-Test
<b>GTV V95</b>	20.6 cc	99.5 %	99.7%	-0.2 %	P=0.32
<b>CTV V95</b>	86.6 cc	98.4 %	98.2 %	0.1 %	P=0.60
<b>PTV V95</b>	187.5 cc	<b>96.0 %</b>	<b>88.8 %</b>	<b>7.3 %</b>	P<0.001

# Results – Normal Tissue

- **IMRT associated with a decreased dose to Breast**
  - IMRT reduced dose at 90 % of data points to IB.
  - Reduced irradiated volume by 6.7 % (V25) to 52.9% (V100)
  - Details in Table 2
- **Improvement with IMRT more when limit analysis to uninvolved breast tissue (IB minus PTV).**
  - IMRT reduced dose at 93 % of data points.
  - Reduced irradiated volume by 10.1 % (V25), 18.7 % (V50), 34.8 % (V75), and 93.1 % (V100)
  - Details in Table 2
- **No clinically significant differences detected in contralateral breast, heart, or lung DVHs.**

# Table 2: Irradiated Volume Comparison (3D-RT -vs- IMRT)

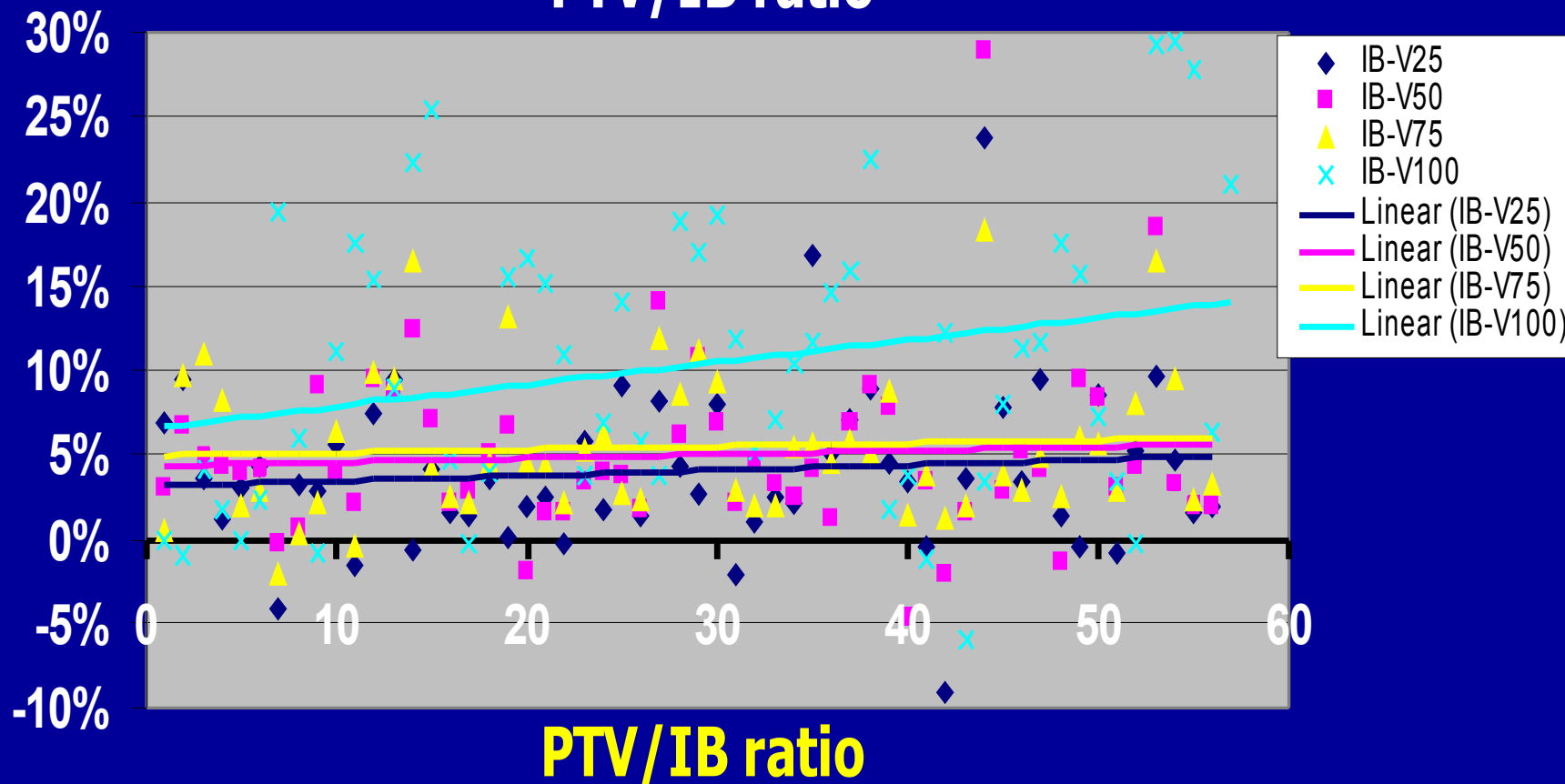
	<b>3D-RT</b>	<b>IMRT</b>	$\Delta$	<b>T-Test</b>	<b>% data improved w IMRT</b>	<b>Mean % Reduction w IMRT</b>
<b>IB</b>						
<b>V25</b>	60.3 %	56.2 %	4.0 %	p<0.001	83.9 %	6.7 %
<b>V50</b>	47.0 %	42.1 %	5.0 %	p<0.001	91.1 %	10.6 %
<b>V75</b>	37.0 %	30.5 %	5.5 %	p<0.001	96.4 %	15.2 %
<b>V100</b>	19.9 %	9.4 %	10.5 %	p<0.001	87.5 %	52.9 %
<b>IB-PTV</b>						
<b>V25</b>	51.3 %	46.1 %	5.2 %	p<0.001	85.7 %	10.1 %
<b>V50</b>	34.5 %	28.1 %	6.5 %	p<0.001	92.0 %	18.7 %
<b>V75</b>	20.5 %	13.4 %	7.1 %	p<0.001	96.4 %	34.8 %
<b>V100</b>	5.8 %	0.4 %	5.4 %	p<0.001	98.2 %	93.1 %

# Results – Subsets

- **The impact of IMRT was the greatest in patients with least favorable anatomy.**
- **Impact of PTV / IB ratio (Figure 1)**
  - Mean PTV/IB ratio 24.3 % (range 7-58%).
  - 25 patients with PTV/IB ratio > 25%
  - IMRT resulted in greater reductions in volume irradiated for patients with larger PTV/IB ratios
  - Especially at the V100.
- **Impact of breast size (Figure 2)**
  - IMRT improvements were more prominent in patients with smaller breasts
  - Especially at the V75 and V100

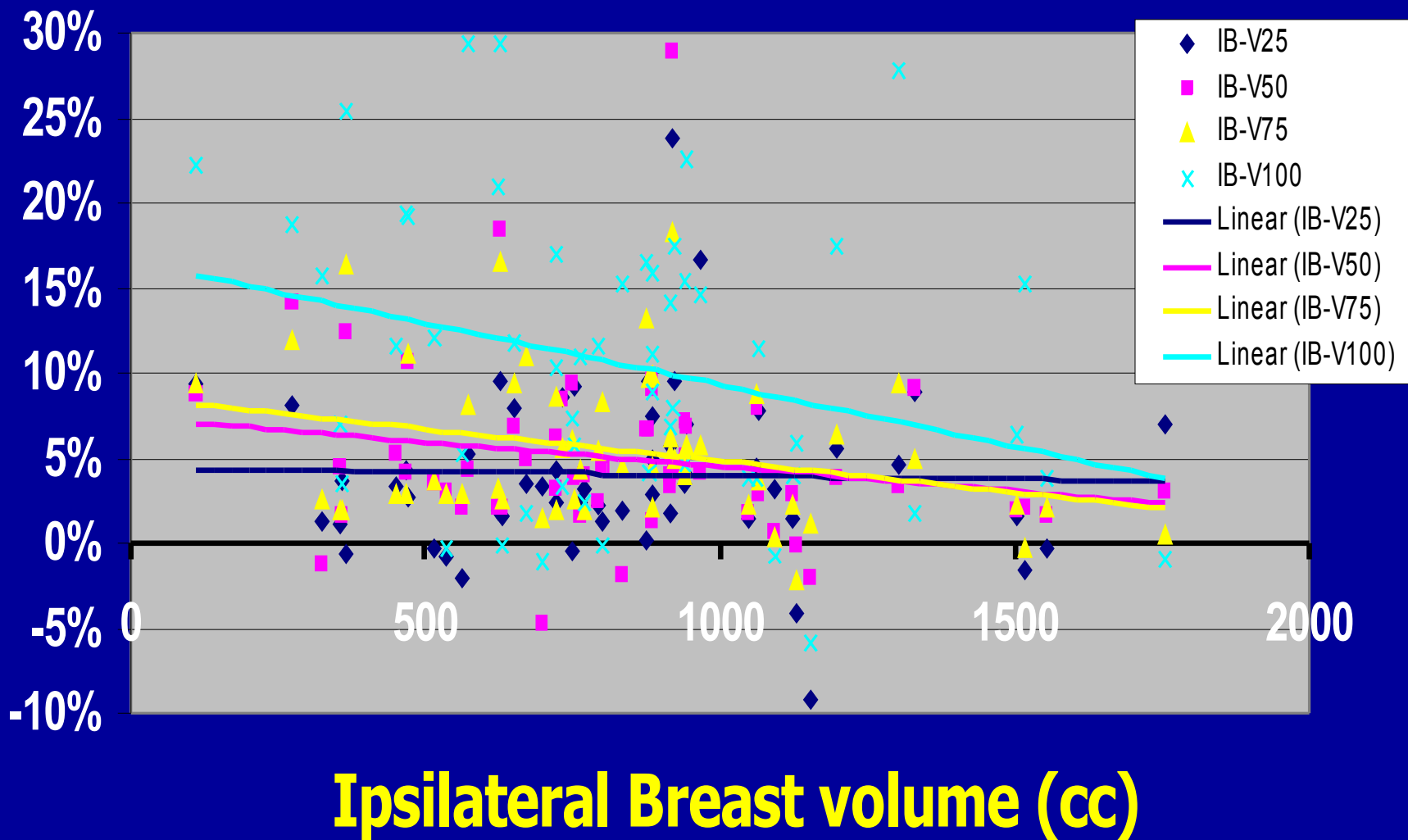
# Figure 1: Trend of IB Volume Irradiated by PTV/IB ratio

Reduced Vol  
with IMRT



# Figure 2: Trend of IB Volume Irradiated by Breast Size

Reduced Volume with IMRT



# Conclusions

- APB-IMRT –vs- 3D-RT
  - IMRT associated with an improved **normal tissue sparing in the ipsilateral breast**
  - No compromise detected in dose delivery to GTV or CTV
  - Improvements were greatest in patients with more challenging dosimetry, including large PTV/IB ratio and small breast size.

# References

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