

# NEW TECHNIQUES IN BREAST RADIOTHERAPY

Anna Shapiro, MD

Lisa Lai, MD

**Upstate Cancer Center**



STATE UNIVERSITY OF NEW YORK

**Upstate Medical • University Hospital**

# RADIATION THERAPY BASICS

- Radiation involves using rays of energy to destroy cancer cells.
- Usually the energy used is **x-rays**
- The cells are destroyed when the energy damages the **genetic material** involved in the growth and division of cells.
- Unfortunately, radiation therapy not only damages cancerous cells, it can also harm healthy cells.
- Precise delivery is important to minimize the effects of the therapy on healthy cells
- Fortunately, healthy cells are usually able to fix most of the damage done themselves



# RADIATION THERAPY FOR EARLY STAGE BREAST CANCER FOLLOWING LUMPECTOMY

- ◉ Radiation is a critical part of Breast Conserving Therapy
- ◉ Lumpectomy +RT= Mastectomy



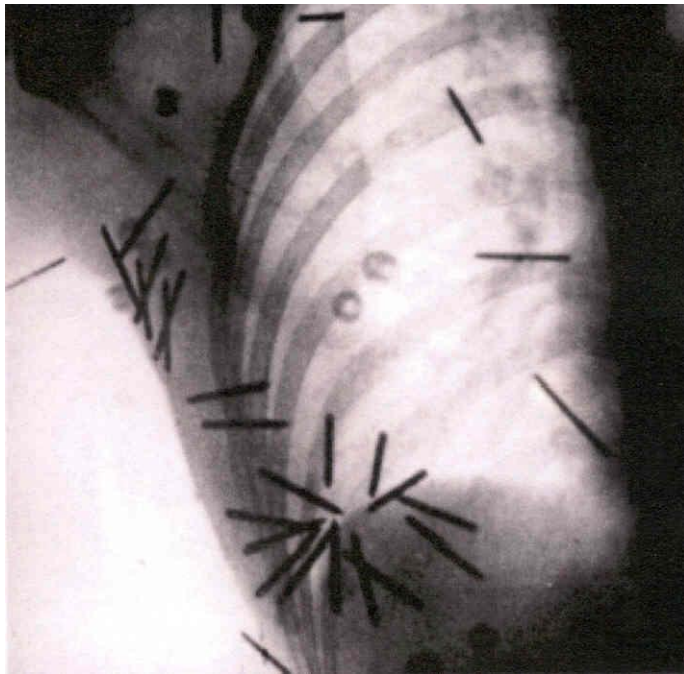
# HOW RADIATION THERAPY IS ADMINISTERED

- **External Radiation:** This kind of radiation therapy uses a machine to target the tumor from outside the body. External radiation generally takes several weeks and is performed on an outpatient basis.
- **Brachytherapy:** Brachytherapy is a kind of internal radiation therapy. It uses a radioactive source that is put inside the body, either in or near the tumor.



# HISTORICAL PERSPECTIVE

Interstitial Radium  
Brachytherapy for Breast  
Cancer 1917



Radiotherapy for  
Breast Cancer,  
London Hospital 1917



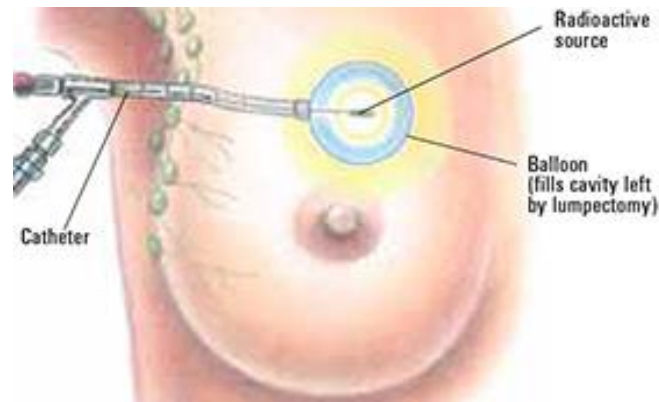
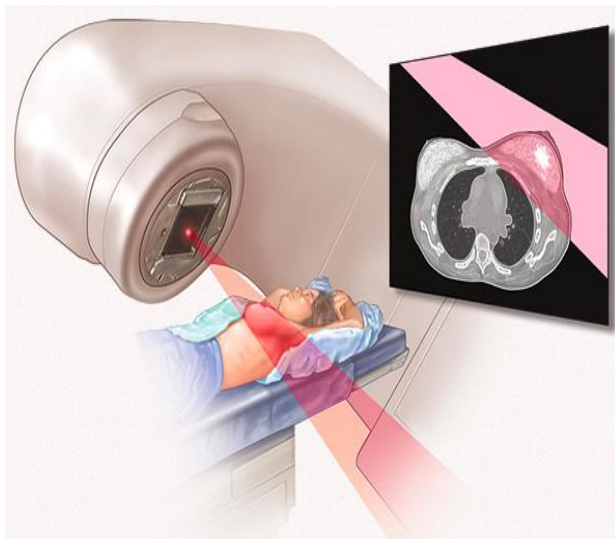
# SIGNIFICANT PROGRESS HAS BEEN MADE IN THE RADIATION PLANNING AND DELIVERY

- Safer: less acute and long-term side effects
- Cheaper/more cost effective
- More accessible/convenient for the patients



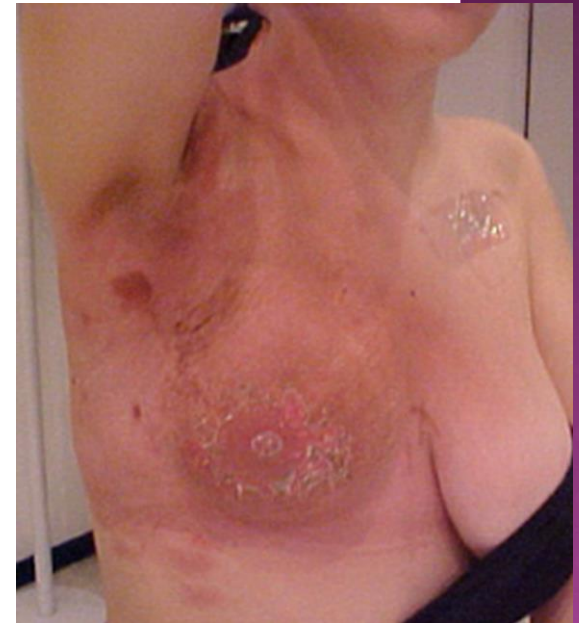
# BREAST CANCER TREATMENT EVOLVES FROM WEEKS TO MINUTES

- Patients with early stage breast cancer have many RT options available to them
  - “Standard” fractionation 5-7 weeks
  - Hypofractionation 3-4 weeks
  - Partial breast radiation 1 week
  - IORT - intra-operative 10-20 min



# RADIATION PLANNING

- Improvements in radiation planning resulted in decreased toxicity
- Acute - decreased rate of radiation dermatitis
  - Grade III moist desquamation 1% vs 10%
- Long term
  - Cardiac toxicity
  - Pulmonary toxicity-pneumonitis
  - Radiation fibrosis of breast
  - Brachial plexus injury

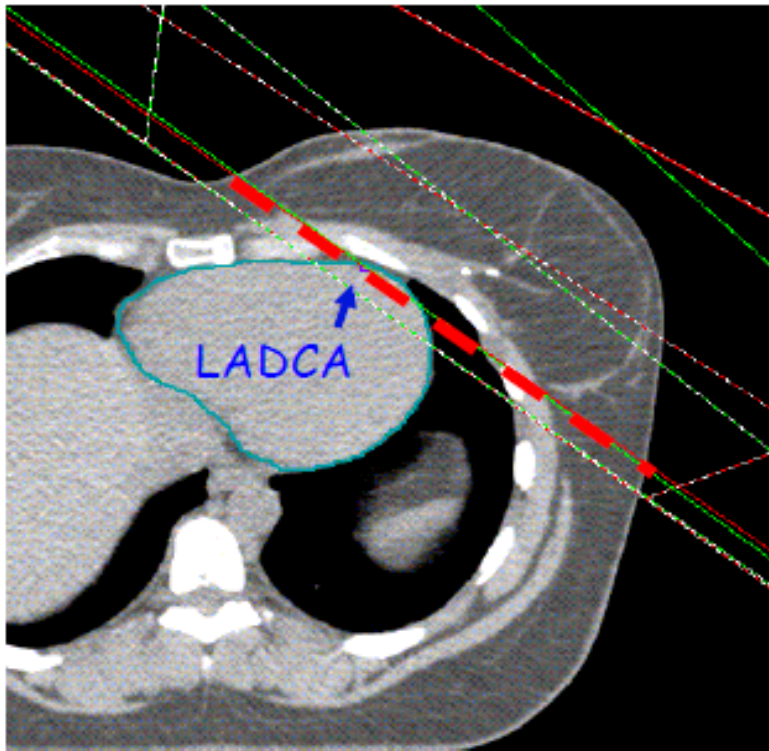




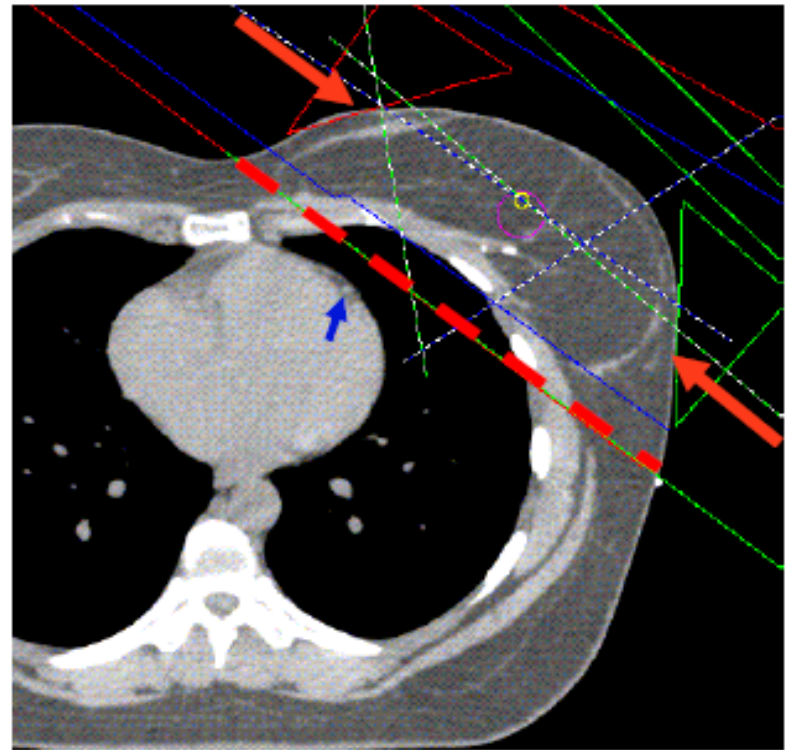
- Novel techniques for delivery of WBI
  - treatment in the prone position
  - gating of treatment to the deep inspiratory phase of the respiratory cycle
- Decrease the radiation dose to the lung and heart

# RESPIRATORY GATING

Expiration:  
Beam **OFF**



Inspiration:  
beams **ON**



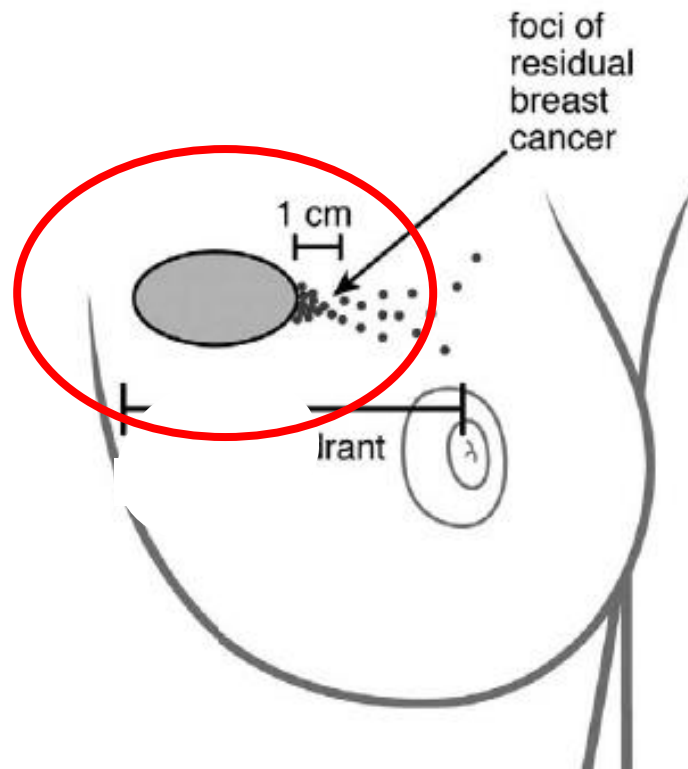
# RT PLANNING: PRONE BREAST RT

- ▶ Suitable for pendulous breasts, where breast-only RT is required
- ▶ Results in reduction of dose to the lung
- ▶ Heart dose may be lower
- ▶ Potential reduction in dermatitis in the infra-mammary fold

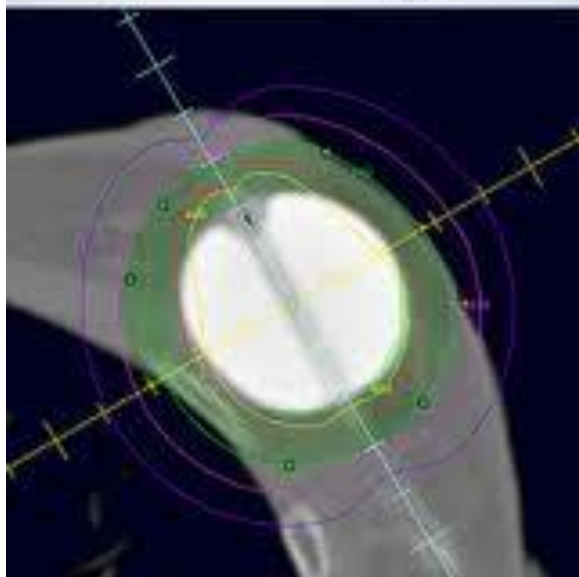


## Majority of recurrences are close to tumor bed...

- Rationale
- decrease treatment time and improvement of quality of life
- reduction in treatment toxicity



# APBI (MAMMOSITE)





# MAMMOSITE

- Typical treatment 5 days twice daily
- Needed balloon-to-skin dist >5 mm, cavity size < 6 cm
- Results:
  - - IBTR = 2.15% (4 yr=2.65%)
- Toxicity:
  - - infection: 9.5%,
  - - Seroma: 27% (13% symptomatic)
  - - 2% fat necrosis
- • Cosmesis: Good or excellent at 4 yrs: 91%

# Breast-conserving therapy with partial or whole breast irradiation: Ten-year results of the Budapest randomized trial

Csaba Polgár<sup>a,\*</sup>, János Fodor<sup>a</sup>, Tibor Major<sup>a</sup>, Zoltán Sulyok<sup>b</sup>, Miklós Kásler<sup>c</sup>

At a median follow-up of 10.8 years, no significant difference in the ten-year actuarial rates of LR, DFS, OS, and CSS between the two treatment arms

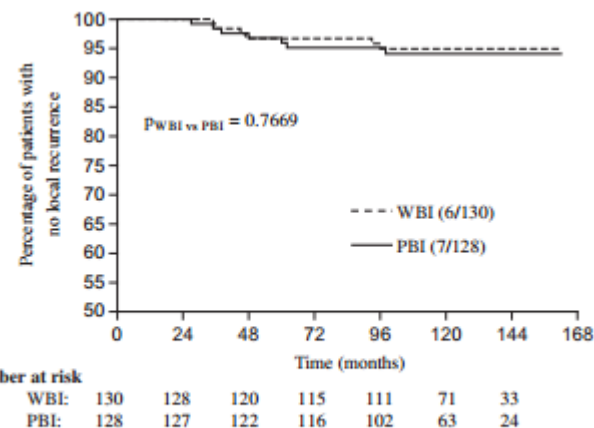


Fig. 2. Time to local recurrence by Kaplan-Meier estimates. Abbreviations: WBI – whole breast irradiation; PBI – partial breast irradiation.

Table 4  
Cosmetic outcome.

Harvard cosmetic score	PBI – HDR BT (n = 85) <sup>a</sup>	PBI – EB (n = 40) <sup>a</sup>	WBI – photons (n = 93) <sup>a</sup>	WBI – cobalt (n = 23) <sup>a</sup>
Excellent	29 (34.1)	7 (17.5)	16 (17.2)	3 (13.1)
Good	43 (50.6)	22 (55.0)	46 (49.5)	8 (34.8)
Fair	11 (12.9)	11 (27.5)	22 (23.6)	11 (47.8)
Poor	2 (2.4)	0 (0)	9 (9.7)	1 (4.3)

Abbreviations: PBI – partial breast irradiation; HDR BT – high-dose-rate brachytherapy; EB – electron beam; WBI – whole breast irradiation. Data are n (%).

<sup>a</sup> n = patient number with data available on cosmetic outcome.

# IORT

- A single dose of targeted radiation given at the time of lumpectomy



# PATIENT SELECTION


- Age > 50
- Invasive ductal carcinoma < 2 cm in size with margins >2 mm
- Low or intermediate grade DCIS, size < 2.5 cm and margins > 3 mm
- Age 40-49 with “suitable” criteria
- Age > 50 AND: tumor 2.1-3 cm, estrogen receptor negative, invasive lobular carcinoma, margins < 2mm, focal LVSI, DCIS < 3 cm not meeting “suitable” criteria

Suitable

Cautionary

# PATIENT SELECTION

- ◉ Age < 40
- ◉ DCIS > 3cm
- ◉ Margins positive



Patient selection is  
key!

Unsuitable



# CLINICAL TRIALS

## ○ Randomized clinical trials:

- ELIOT trial: Intraoperative radiotherapy with electrons
- TARGIT-A trial: 2000-2012. 5-year results of risk-adapted IORT versus WBRT.
  - >3000 patients in 11 countries
  - 5 year recurrence IORT 3.3% versus WBRT 1.3%
  - IORT concurrent with surgery 2.1% versus 1.1%.
  - Fewer non-breast cancer deaths from stroke, MI and other cancers
  - Radiation-related quality of life factors: less pain, less breast and arm symptoms, better overall function

## ○ Registries:

- Dr. Mel Silverstein's group, 2010-2017. 1000 cancers treated with Xofig IORT: Age >40, tumor < 3 cm, 94% ER positive. 28 ipsilateral recurrences (4 at the lumpectomy site, 13 same quadrant, 11 other quadrant), 4 axillary recurrences, 1 distant metastasis, no BC related deaths

# BENEFITS

- ◉ Convenience
- ◉ Targeted treatment spares healthy tissue
- ◉ Fewer side effects
- ◉ Access to care
- ◉ Improved quality of life
- ◉ Reduced cost

# Axxent<sup>®</sup> Controller Components

Display  
Screen/  
Touch  
Screen  
Control

Well  
Chamber

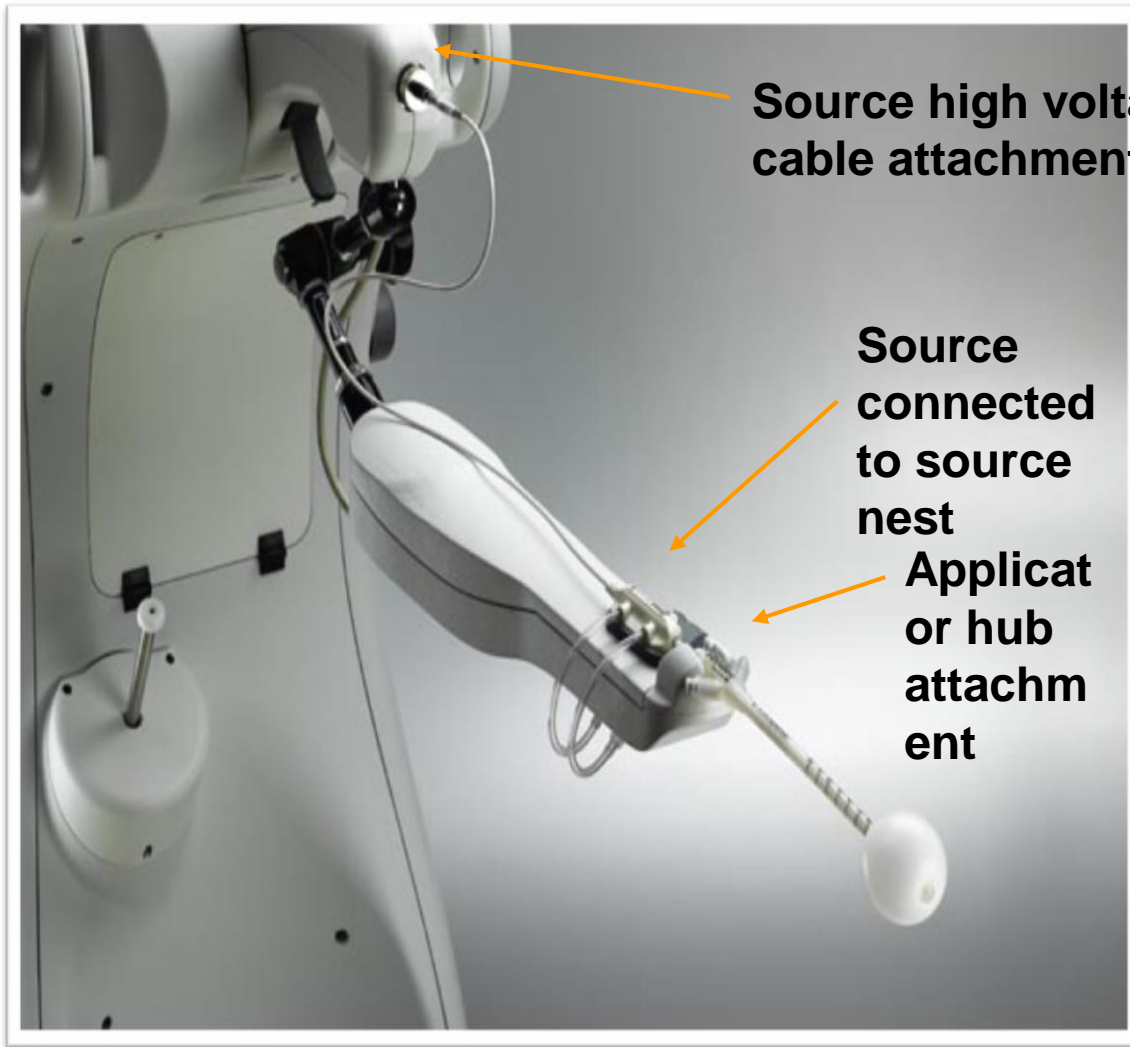


Handheld  
Barcode  
Scanner

Adjustable  
arm  
(in storage  
position)

Wheel  
Brakes

# AXXENT<sup>®</sup> CONTROLLER COMPONENTS



# Miniaturized X-ray Tube :

## The Electronic Brachytherapy Source



The Source Operates  
at 50 kV and 300  
microamps

(15 Watts)

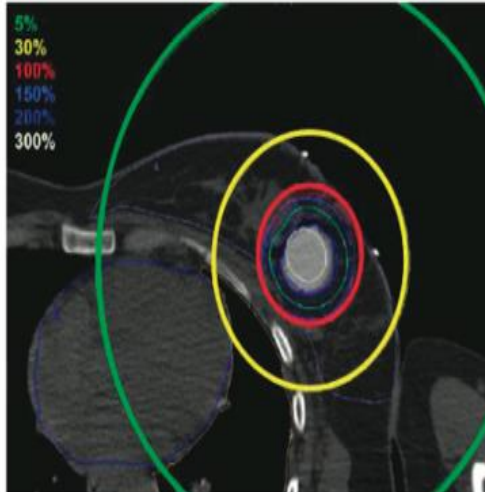
Low energy – High dose non-  
isotopic disposable source is  
unique to Xoft and allows for  
safe placement of source into  
surgical site without the need of  
a shielded bunker.

The lower energy of electronic  
radiation permits the treatment in  
an OR



# EBX<sup>®</sup> HIGH DOSE, LOW ENERGY DELIVERS LESS RADIATION TO CRITICAL STRUCTURES (HEART, LUNG)

## MammoSite Ir-192 HDR



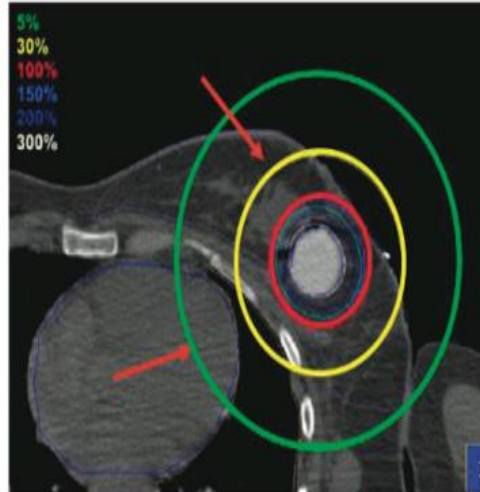
Target  $V_{100\%}$  - 96.5%

Breast  $V_{50\%}$  - 19.8%

Lung  $V_{30\%}$  - 3.7%

Heart  $V_{5\%}$  - **59.2%**

## Xofig 50 kV Source



Target  $V_{100\%}$  - 96.5%

Breast  $V_{50\%}$  - **13.0%**

Lung  $V_{30\%}$  - **1.1%**

Heart  $V_{5\%}$  - **9.4%**

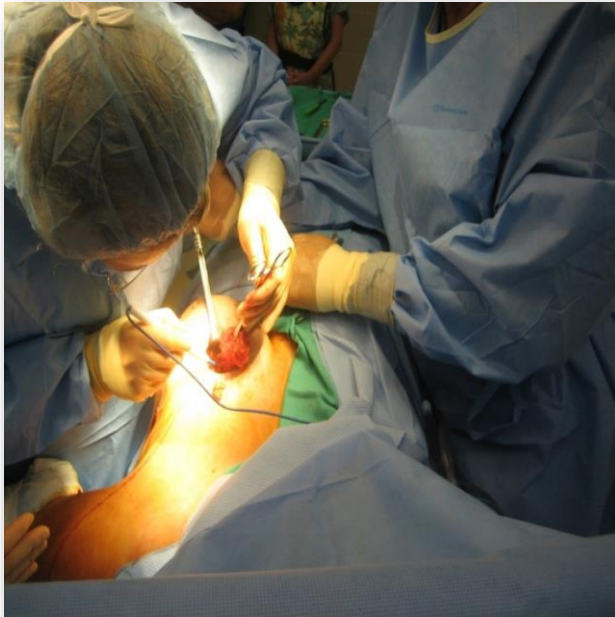
Dickler, et al. "A dosimetric comparison of MammoSite high dose rate brachytherapy and Xofig Axxent electronic brachytherapy," Brachytherapy (6) 2007, 164-168.. Slide courtesy of Dr. David Wazer

# NO MODIFICATIONS TO THE OR



1. SENTINEL LYMPH NODE BIOPSY

2. TUMOR REMOVAL AND CAVITY  
EVALUATION





# Fill Balloon and Close Cavity With Sutures



# Ultrasound to Confirm Skin Bridge

Minimal distance from balloon applicator surface to epidermis must be 1cm.

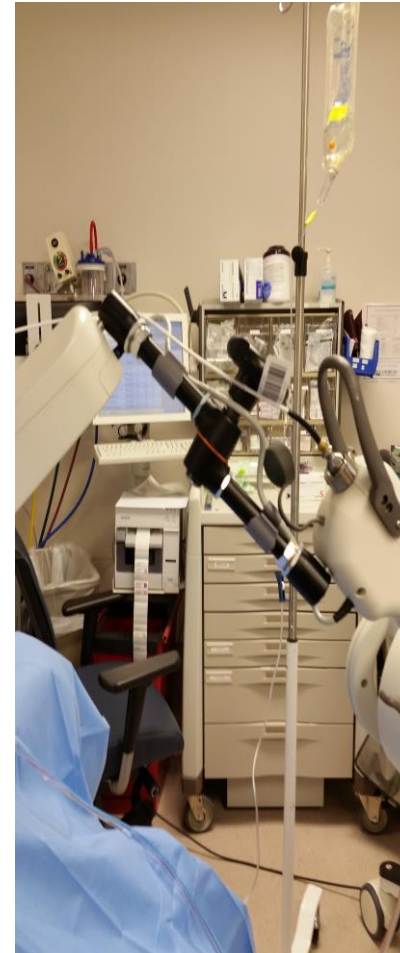


**Measure Skin Bridge  
( $\geq 1$ cm)**





# MACHINE CONNECTION







# QUESTIONS?



**Upstate Cancer Center**



STATE UNIVERSITY OF NEW YORK  
**Upstate Medical • University Hospital**