Prone Breast, Pre-Surgery. A case study; The OSU Way.

Karla Kuhn, CMD, RT(R)(T)
Lee Culp, M.S. CMD, RT(T)

June 2017
• Third largest cancer hospital in the nation
• 21 stories
• 1.1 million square feet
• 306 inpatient bed, including 36-bed BMT unit
• 140 ICU beds
• 14 operating rooms
• 6 interventional radiology suites
• 7 linear accelerators for Radiation Oncology
• Dedicated early-phase clinical trials unit
• Opened December 14th 2014

We are here!
Disclosures

- No disclosures relative to the presented material

- The following presentation is a reflection of studies, protocols, and opinions

- No Honorarium has been received in regards to the subsequent material

- Eclipse™ v.13.6.30
Meet the Speaker

- Karla Kuhn, CMD RT(R)(T)
- 9 years Radiation Therapist
- 11 years in July as a Dosimetrist
- Lead Dosimetrist at SSCBC in August 2014
Meet the Speaker

- Lee Culp, M.S CMD RT(T)
- Dosimetrist at OSU - SSCBC
- Masters in Dosimetry from University of Wisconsin – La Crosse
- Has two Bachelors degrees – one in Communication and the other in Business
Radiotherapy at OSU

- The “New” James Cancer Hospital
  - Opened December 2014
  - All disease sites except Breast
- Stefanie Spielman Comprehensive Breast Center - SSCBC
  - Opened January 2011
  - All Breast and Breast metastasis
Our Clinic

The Stefanie Spielman Comprehensive Breast Center (SSCBC) at the Ohio State University

The James
Breast cancer Epidemiology

- Most commonly diagnosed cancer among women
- Second leading cause of cancer death among women after lung cancer
- Annual Diagnosis
- Death Rate
- Lifetime risk of dying from Breast Cancer?
History of Breast Cancer – an evolution with time

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THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER
First documented cases

- When was Cancer first diagnosed?

- What about Breast Cancer?

- In 460 B.C *Hippocrates* named cancer “Karkinos” a Greek word for crab
First documented cases

- 440 B.C. Greek historian *Herodotus* recorded the Queen of Persia, *Atossa*, noticed a bleeding lump in her breast.

- Wrapped herself in sheets and sought a self-imposed quarantine, ashamed by the tumor

- This tumor was excised by her Greek slave, *Democedes*

https://en.wikipedia.org/wiki/Atossa
Early Treatments

- Theorized that breast cancer spread locally into muscle, regional nodes, and then distant metastasis

19th century – surgical procedures were developed
William Halsted developed the Halsted Radical Mastectomy used from late 1890-1970s
Theorized that breast cancer spread locally into muscle, regional nodes, and then distant metastasis
Radical Modified Mastectomy

Modified radical mastectomy
Early Stigmas of Breast Cancer

- For most of the 20th century, cancer was a word to be avoided in polite conversation

- In the 1950’s a woman called the New York Times to place and ad for a Breast cancer survivors group

  Carried a Negative Stigma

- In the 1950s people were confused about Breast cancer because there wasn’t enough information
Changes in Mentality of Treatment

- Historically there was not much documented about the disease, nor treatment
- Only until recently in the 1990s did we see REAL advances
- Today you may be confused about treatment and Breast Cancer as a whole

- Post-operative vs. Intra-operative vs. Pre-operative
Evolution of RadioTherapy Breast Planning

Where did we come from?

Supine 2D – The Past

- Done by Simulator
- Borders marked visually by Physician with wire
- Half-beam blocked technique
- Gantry angle chosen from crossing of medial and lateral wires
- Standard of 2 cm of lung treated
- Used mobile contour plotter to achieve a 2D treatment plan
3D – The Present

- Free Breathing → DIBH → Prone
- Done by CT Simulator
- Border is marked visually by Physician with wires to use as a guide when contouring
- Dosimetrist contours Organs at Risk; MD contours target volumes
- Dosimetrist utilizes all 3D tools: Conformal, and if necessary, Static field IMRT planning to achieve our Dosimetric goals
Where are we going?

- The Future of Breast Planning:

  Protocol OSU 13282 – Feasibility of assessing Radiation Response with MRI/CT Directed *Pre-Op* Accelerated Partial Breast Irradiation in the *Prone* Position for Hormone Response early stage Breast Cancer

*Partial Breast Irradiation Pre-Op in the Prone position using MRI/CT fusion guidance*
Benefits Prone Breast Radiotherapy

- Better dose homogeneity due to smaller separation
- Reduces skinfolds
- Distances the breast from the chestwall
- Reduction in chestwall Motion
Indications for Prone Breast Radiotherapy

- Breast size is not the only indicator for prone RT
  - Larger and/or pendulous breasts
  - Small breast
- Left sided breast cancer patients
- Smokers, severe COPD

- Approximately 75% of patients at SSCBC undergoing post-lumpectomy breast radiotherapy are treated in prone position
Prone Breast Planning at SSCBC

- Protocols used
- OAR & Targets
- Goals
Organs at Risk
- Heart
- Left Lung
- Right Lung
- Contralateral Breast
- Sternum
- Thyroid

Physician Drawn Targets
- Breast CTV
- Breast PTV
- Breast PTV Eval
- Lumpectomy (Lump) GTV
- Lump CTV
- Lump PTV
- Lump PTV Eval

*In Prone (and Supine DIBH) at SSCBC the CTV to PTV expansion is reduced to 5mm due to limited chestwall motion*
Targets Contoured:

- Lump GTV
- Lump CTV
- Lump PTV Eval
- Breast PTV Eval
- Breast CTV

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# Constraints & Goals

## RTOG 1005 & 1304

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<tr>
<td>Lump PTV Eval</td>
<td>95%/95%</td>
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<tr>
<td>50% Breast PTV Eval</td>
<td>&lt;108%</td>
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<td>VBreast Receiving Boost Dose</td>
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## SSCBC

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*Boost (when indicated) & Whole Breast planned simultaneously in Prone Position. Constraints & Goals evaluated in Plan Sum.
Hypofractionated/Canadian Fractionation

- SSCBC Guidelines for Hypofractionation
- Stage 1 or 2
- No Lymph Nodal Involvement
- Hormone Receptor positive
- 60+ years (sometimes women 50+ years)
- No prior chemotherapy

Standard Fractionation
2.0Gy * 25 FX = 50.0 Gy

VS.

Hypofractionated Prescription:
2.66Gy * 16 FX = 42.56Gy
Prone with Boost

- Boost is planned at time of Initial plan
- Boost is in Prone position as well
- “Simultaneous Boost” hotspot placed in the Lump PTV Eval
- Plan evaluated in Plan Sum
- “Ski slope”
  - V46

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Breast failures occur at or near the location of original lesion in 75-90% of cases for Whole Breast Irradiation (WBI).

Major therapeutic effect of WBI may actually be at the surgical site.

Therefore:

APBI delivers radiation to adjacent 1-2cm of Breast tissue at highest risk for recurrence instead of targeting entire breast.
Rationale for Post-Surgery APBI

- Shortening overall treatment course
- Reducing radiation dose to lower risk ipsilateral breast tissues
- Decrease Toxicity
- Improving overall utilization of breast conserving therapy

*Can be delivered via Brachytherapy, 3D Conformal Therapy (3DCRT), and IMRT*
Post-Surgery APBI Fractionation Schedule

- 3-6 Gy
- 5-10 Fractions
- Delivered 1-2 times a day
- Over 5-8 day treatment course
- *APBI Post-Surgery*
Patients Suitable for Post-Surgery APBI

- Women
- Over 50 years of age
- Undergone successful lumpectomy with negative surgical margins and sentinel node biopsy confirming Stage I
- Hormone responsive disease
- Committed to completing anti endocrine therapy
Post-Op APBI

- Delivering Post-op radiation disrupted blood & lymph supply
  - May be suboptimal in terms of radiosensitivity
  - Limits the opportunity to observe radiation-induced tumor response
- MRI important tool for measuring extent of disease prior to neoadjuvant chemo and response after
  - Whether MRI correlates with radiation response may be similarly identified
Woman
65 years old
Stage IA (cT1bcNo)
ER+/PR+/HER 2-
No Lumpectomy

How would you treat her?

A. 25FX Total Dose 50Gy
B. 16FX Total Dose 42.56Gy
C. 15FX Total Dose 40.0Gy
D. Post Surgery APBI
E. None of the above
Answer

A. 25FX 2.0Gy TD = 50Gy
B. 16FX 2.66Gy TD = 42.56Gy
C. 15FX 2.67Gy TD = 40.0Gy
D. Post Surgery APBI
E. NONE OF THE ABOVE
Pioneering Treatment Early Stage Breast Cancer at OSU

Protocol OSU 13282 – Feasibility of assessing Radiation Response with MRI/CT Directed Pre-Op Accelerated Partial Breast Irradiation in the Prone Position for Hormone Response early stage Breast Cancer

Primary Investigator Dr. Julia White
Primary Hypothesis:

MRI will improve targeting, planning and delivery, and that MRI features can be identified to correlate with pathologic radiation response. Identification of a poor radiation response group will permit investigation of novel treatment approaches (e.g. dose escalation and/or radio sensitizers).
Primary Goal:

- Assess the technical feasibility and associated radiation-surgical toxicity of a novel method of delivering APBI preoperatively

- MRI highly sensitive for detecting cancer of the breast and for response to treatment
  
  Therefore, radiation may be more ideally targeted based on MRI-defined preoperative disease location versus surgical cavity location
Rationale for Pre-Surgery APBI (OSU 13282)

- Inherent targeting for accuracies for the lumpectomy cavity
- Unknown radiation response
  - Illustrated below, this cavity may not necessarily or accurately direct placement of the radiation field optimally toward the highest risk area of the breast around the tumor
Eligibility for *Pre*-Surgery APBI (OSU 13282)

- Women
- Over 50 years of age
- Core Biopsy proven hormone responsive Breast Cancer
- Unifocal Breast Cancer
- Able to undergo MRI Imaging with contrast
- No Prior malignancy (<5 years prior to study entry)
- No collagenous disease
- No previous Hormonal Therapy, Radiation or Chemo for current Breast Cancer
- Life expectancy 2+ years
CT scan with patient in prone position

MRI scan with patient in same prone position as CT
  - MRI & CT fused together

Dosimetrist contours OAR

Physician contours GTV from fused MRI/CT
  - GTV: MRI defined tumor + 10mm margin
  - CTV: uniform expansion of GTV of 15mm
  - PTV: 5mm expansion of CTV
    - Excluding chest wall musculature and cropped 5mm from skin

Protocol OSU 13282
Protocol OSU 13282

- 33 Patients
  - Cohort 1: 3 patients to verify flow between MRI and CT
  - Cohort 2: 30 patients receive radiation treatment

- Prescription Dose = 38.5Gy in 10Fx, 3.85Gy BID, separated by at least 6 hours, delivery in no less than 5 and no more than 10 business days

- Follow up MRI completed 4 weeks post radiation and before surgical resection to assess response
Protocol OSU 13282

Consent Registration

- Core Biopsy
- Biomarkers (ER/PR / HER2)
- Clips
- Staging

MRI & CT for RT planning

Weeks
0 1 2 3 4 5 6 7....Follow up

MRI for RT response

- Lumpectomy + Sentinel node
- Pathology

APBI (10 x 3.85 Gy)/ 5 days BID Prone/IG-IMRT

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Extra immobilization devices are used for patient comfort.
CT Prone Positioning

- Index Immobilization
- Patient starts low on hands & knees before laying down. Inframammary fold should fall just above the inferior opening of the insert
- Smoothing of the belly tissue may be needed
- Elbows bent in Vac-bag to ensure arm reproducibility & comfort. Location of headrest is marked
- Contra breast should be gently pulled “down & out” and rest on the sternal sponge
  - Sponge placed under contra breast (if needed)
- Head turned toward the contra side
- Back should be as flat as possible with shoulders relaxed
5 Tattoos

Ipsilateral Tattoo

Board number on index bar in line with mid-nipple or other designated breast mark

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5 Tattoos (cont’d)

Contralateral Tattoo

3 PA Tattoos

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Pre-Surgery APBI – Tricks & Tips

Sans Sponge

*Note the position of the contralateral Breast

With Sponge

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Pre-Surgery APBI – Tricks & Tips

- Manufactured “Test” MRI bore device
Pre-Surgery APBI – Tricks & Tips
MRI Prone Positioning

- MRI scan with patient in same prone position as CT
  - MRI & CT fused together
- MRI times: ~18 minutes to complete 4-5 series for this protocol
  - Normal Breast MRI’s are 6 series for a total of ~25min
- Extremity coil is used in MRI
  - Taped to immobilization for stability
- Contrast IS used during MRI
  - But not all series
MRI Prone Positioning

Notice how tight her elbows are in the Vacbag. This is to allow clearance for MRI.
Chosen MRI Series: MR t1_fl3d FS C+
OSU 13282; Work flow after CT & MRI

- Radiologist reviews the MRI series
  - Chooses best series
- Dosimetrist fuses chosen MRI series with CT Sim
  - Physicist reviews fusion
- Rad Onc draws in MRI GTV, GTV, and expansions
  - Radiologist reviews targets if necessary
- Dosimetrist creates plan
CT/MRI Images

CT Image

MRI Image
CT/MRI Images Fused

CT/MRI Fused

CT/MRI Fused with targets on

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Protocol OSU 13282 – Planning Objectives

- **PTV**
  - D99 $\geq$ 95%

- Uninvolved normal breast
  - V19.25Gy < 50%
  - V38.5Gy < 30%

- Contralateral breast
  - D0.03cc < 1.15Gy

- Ipsilateral lung
  - V11.55Gy < 15%

- Contralateral lung
  - V5.78Gy < 5%

- Heart (right-sided lesions)
  - V1.93Gy < 5%

- Heart (left-sided lesions)
  - V1.93Gy < 40%

**Note:** V19.25Gy = Volume receiving 19.25Gy of the prescribed dose or more
Organs at Risk

- Heart
- Left Lung
- Right Lung
- Contralateral Breast
- Thyroid
- Sternum

Physician Drawn Targets

- MRI GTV
- GTV
- CTV
- PTV

*Dosimetry guidelines from the NSABP B39/RTOG 0413 study established for 3D conformal RT with patient in supine position
Where do we start?

Attempted VMAT

This lead to too much uninvolved Breast dose, Contra Breast dose, and Heart dose

Moved to Static IMRT Planning

Which beam angles for IMRT??
<table>
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<th>Volume [cc]</th>
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**Beam Angle Optimizer**

**Planning OSU 13282**

**Calculation Options**

Global optimization:

- Coplanar

Local optimization:

- Powell
  - Min number of fields: 5
  - Max number of fields: 9

Performing GLOBAL optimization...

71/71 fields left

Optimizing... 0h 0m 17s
Planning OSU 13282

Beams used...
Planning OSU 13282
Protocol OSU 13282

- Met ideal constraints and objectives
- 9 field static IMRT
- VMAT attempted
- Unable to meet contralateral breast max dose (D0.03cc < 1.15Gy)
Well under protocol requirements for amount of normal breast tissue receiving 50% and 100% of prescription dose

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VSim & Treatment Setup

- Patient adjusted Right to Left, Sup and Inf, and rolled to align tattoos to lasers.

PA and Lateral SSD is checked
Pre-Op APBI Imaging

- V-Sim Always performed with physician present
- Orthogonal kV pairs taken for isocenter verification
- Shifts made (if necessary)
- CBCT taken to finalize isocenter verification
- PA, lateral, and treatment SSDs are verified
Pre-Op APBI Imaging – Orthogs

kV PA Setup

kV RLat Setup

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Pre-Op APBI Imaging - CBCT
Pre-Op APBI Post Radiation

- Chemotherapy
- Anti-endocrine Therapy
- Lumpectomy and Sentinel node Biopsy
- Follow-Up MRI
Key Components for Successful Prone Treatments

- Integrated team of specialists
- Full patient compliance and understanding
- Proper equipment
- Established Policy & Procedure

Image Source: http://www.engagingothers.com/2012/02/are-you-putting-the-me-in-team/
References/Contributions

- Dr. Julia White
- Dr. Jose Bazan
- Tina LaPaglia (Lead Therapist SSCBC)
- Dominic DiCostanzo, physicist
- Kristen Krupela CMD
Thank You

To learn more about Ohio State’s cancer program, please visit cancer.osu.edu or follow us in social media:

Lee.Culp@osumc.edu
Karla.Kuhn@osumc.edu
Just a reminder to get a breast exam while you're visiting the doctor's for the cold you think is Ebola.

someecards
SAVE THE TATATATATATAS
please