2063 Changes in Breast Tissue Oxygenation following Radiotherapy

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Purpose/Objective(s): Small vessel damage and fibrotic changes are thought to occur following radiotherapy. Decreased blood flow and decreased oxygenation may result from radiotherapy and contribute to long-term toxicity. We sought to test the hypothesis that normal tissue becomes hypoxic following radiotherapy.

Materials/Methods: Transcutaneous oxygen sensing electrode probe was used to determine breast tissue oxygen levels in irradiated and non-irradiated breast tissue one year after breast conserving therapy for early stage breast cancer. Oxygenation was measured at the lumpectomy site and a distant site in the irradiated breast for each subject. Oxygenation levels were also determined at corresponding locations in the non-irradiated (control) breast. Radiation Therapy Oncology Group toxicity criteria were used to assess skin and subcutaneous tissue damage. Measurements from twenty subjects were analyzed. Oxygenation levels were compared using a t-test for equality of means.

Results: Transcutaneous measures of tissue oxygenation one year following breast radiotherapy were lower in irradiated versus control tissue. Subjects without diabetes had an average oxygenation level of 64.8 +/- 19.9 mmHg in the irradiated breast at the non-lumpectomy site and an average of 72.3 +/- 18.1 mmHg (p=0.014) at the corresponding location in the control breast. One subject had developed clinical grade 2 cutaneous changes one year after treatment, all others showed grade one changes. The subject with grade 2 toxicity had oxygenation levels of 74.5 and 58.8 in the control and irradiated breasts, respectively. Patients with diabetes ($n = 4$) showed a different oxygenation pattern, with lower oxygenation levels in control tissue and no decrease in the irradiated breast.

Conclusions: Radiotherapy appears to decrease breast tissue oxygenation in non-diabetic patients one year after treatment. Transcutaneous oxygenation measurements may provide a useful tool to assess and quantify normal tissue injury following radiotherapy.

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2064 Image-based Treatment Planning of the Post-lumpectomy Breast Utilizing CT and 3T MRI

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Purpose/Objective(s): Compare lumpectomy cavity volume, extent, and cavity visualization score (CVS) as obtained from CT versus 3T MRI.

Materials/Methods: From September 2008 to March 2009, 12 patients referred for intact breast irradiation had breast imaging with both CT and 3TMRI. 14 sets of images were obtained. CT scans were performed with patients in the supine treatment position, both arms extended above the head on a commercial arm board, with wires defining the breast and scars. An MRI was performed immediately afterward in the same position. MRI scans were obtained on 3T (Siemens TRIO TIM) Scanner using a flexible six-element body RF matrix coil. The coil was placed over the patient's chest in the supine position. The 3D T1 weighted images were acquired using VIBE (Volumetric interpolated breath-hold exam) sequence with TR/TE: 3.37/1.23 ms, 1 NEX at $2.4 \times 2.0 \times 2.0$ mm spatial resolution in parallel imaging mode (acceleration factor of 2) yielding 104 slices in 0:21 min. T2 weighted images were obtained using a Turbo spin echo sequence with TR/TE: 6440/127 ms, 3 NEX at $2.1 \times 1.6 \times 3.0$ mm resolution with acceleration factor of 2 yielding 30-56 slices in 6:02 min. Three individuals (observers) independently contoured the lumpectomy cavity on CT and MRI images. Measures of consistency and agreement between observers for CT volume and MRI volume were evaluated by the Intra-Class Correlation Coefficient (ICC) obtained from a random effect ANOVA model. All patients had CT and T1 MRI scans, seven had an additional T2 MRI scan. Statistics are based on comparing 14 CT images with 14 T1 MRI images. The observers assigned each image a cavity visualization score (CVS) of 1 (cavity not visualized) to 5 (all cavity margins clearly defined).

Results: Measures of consistency and agreement for CT volumes were 98.94% and 98.89%. Measures for MRI were 95.13% for consistency and 95.27% for agreement. There is a strong and significant agreement between observers. Observers do not differ much in their assessment of CT vs. MRI. However, there was a significant difference in the perceived quality of the image. MRI image quality was clearer. The mean CT and MRI scores were 3.56 and 3.85 respectively; significantly different with a p-value of 0.008. With regards to specific details; observers indicated that surgical clips were visualized on CT but not MRI. MRI better demonstrated margins at the skin and chest wall.

Conclusions: There are advantages to each imaging modality. CT allows for visualization of surgical clips, which can be critical in defining the area to be treated. MRI provides a better quality image for ease and precision for contouring. The MRI and CT images provide complimentary information in definition of the target volume planning of the post-lumpectomy breast.

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2065 A Contura Catheter Offers Dosimetric Advantages over a MammoSite Catheter that Increase the Applicability of Accelerated Partial Breast Irradiation

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Purpose/Objective(s): To determine whether a Contura catheter can increase the applicability of accelerated partial breast irradiation.

Materials/Methods: We treated 182 women with unifocal pathological Tis, T1, or T2 (up to 3.0 cm), N0, N1mic, or N1a ductal, colloid, or tubular carcinomas of the breast at least 0.1 cm from the lumpectomy margin with high dose rate brachytherapy to 34 Gy in 10 fractions bid separated by 6 hours daily over 5-7 days using a Contura multi-lumen catheter ($n = 45$) or a MammoSite

single-lumen catheter (n = 137). Hypothetical MammoSite treatment plans were created for the Contura patients. Multiple dwell positions were used for all patients to optimize dose delivery. The volumes of breast tissue receiving 150% (V150) and 200% (V200) of the prescribed dose were limited to ≤50 cc and ≤10 cc, respectively. Treatment planning goals were to: 1) avoid a radiation "hot spot" in the skin, and 2) have only a small air/fluid pocket next to the balloon.

Results: Median follow-up was 16 months. The minimum balloon-to-skin distance was <7 mm in 16% (7/45) of Contura patients and 12% (17/137) of MammoSite patients (p=0.78). The maximum skin dose was 100% of the prescribed dose with a Contura catheter vs. 145% of the prescribed dose with a MammoSite catheter. Air/fluid next to the Contura balloon was at least partially removed in 71% (32/45) of patients. The volume of air/fluid next to the Contura balloon was 5.0% ± 0.7% (mean ± standard error) of the planning target volume for plan evaluation (PTV_EVAL) before suctioning vs. 1.3% ± 0.2% after suctioning ($p < 0.001$). Eighty-nine percent (40/45) of Contura plans satisfied both treatment planning goals vs. only 36% (16/45) of hypothetical MammoSite plans ($p < 0.0001$). A Contura catheter did not require explantation in 16% (7/45) of patients where balloon-to-skin spacing was only 3-6 mm and in 11% (5/45) of patients where there was an air/fluid pocket next to the balloon >10% of PTV_EVAL prior to suctioning. A MammoSite catheter was explanted in 10% (15/152) of cases where the minimum balloon-to-skin distance was <7 mm and in 13% (20/157) of cases where there was an air/fluid pocket next to the balloon >10% of PTV_EVAL. The incidence of acute toxicity with a Contura catheter was similar to that with a MammoSite catheter.

Conclusions: A Contura catheter does not require explantation in cases where balloon-to-skin spacing is only 3-6 mm or an air/fluid pocket next to the balloon is >10% of PTV_EVAL prior to suctioning, thereby increasing the applicability of accelerated partial breast irradiation. Phase III clinical trials will help to determine whether accelerated partial breast irradiation offers advantages over standard whole breast irradiation.

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2066 Imaging and Receptor Status as Predictors of Pathologic Complete Response to Neoadjuvant Chemotherapy in Breast Cancer

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Purpose/Objective(s): Pathologic complete response (pCR) to neoadjuvant chemotherapy is a strong predictor of outcome in breast cancer. Our aim is to identify predictors of pCR, and to evaluate the rates of loco-regional recurrence (LRR) among patients with pCR to neoadjuvant chemotherapy followed by surgery and radiation (XRT).

Materials/Methods: The case histories of 156 patients with invasive breast cancer treated with neoadjuvant chemotherapy, surgery, and XRT from October 1997 to August 2008 were analyzed. The clinical stage at diagnosis was I in 2%, II in 56%, and III in 42% of patients. Patients received preoperative systemic therapy with a doxorubicin-based regimen (94%), a single-agent taxane regimen (3%), or hormonal therapy alone (3%). Multivariate logistic regression was used to identify predictors of pCR. LRR rates were calculated by the Kaplan Meier method. Median follow-up time was 35 months.

Results: Of the 156 cases, 31 (20%) had pCR, 97 (62%) had partial response, 26 (17%) had no response (pNR) and 2 (1%) had unknown pathological response. Compared to non-pCR patients, pCR patients had a higher percentage of ER-/PR- tumors (85% v 42%, $p = 0.0001$), and Her-2/neu+ tumors treated with trastuzumab (32% v 9%, $p = 0.004$). A higher percentage of triple negative patients achieved pCR than non-triple negative patients (42% v 23%, $p = 0.045$). There were no differences between the two groups with respect to age, menopausal status, histological type, clinical T stage, or clinical N stage. ER-/PR- tumors (p =0.0007) and Her-2/neu+ tumors treated with trastuzumab ($p = 0.007$) were significant independent predictors of pCR. One or more positive nodes at presentation (p =0.017) and clinical T3-4 tumors ($p = 0.001$) were predictors of pNR. Imaging prior to surgery by mammogram or MRI was superior to clinical exam alone in predicting pCR ($p = 0.03$). Patients with pCR to neoadjuvant chemotherapy had a lower rate of LRR (0% v 10.6%), a higher overall tumor recurrence-free survival at 3 years (92.5% v 81.8%, $p = 0.01$), and a higher overall survival rate at 3 years (92.5% v 85.8%, $p = 0.04$).

Conclusions: Breast imaging prior to surgery was more accurate than clinical exam in identifying patients with pCR. Our results suggest that imaging, in addition to clinical exam, should be part of assessing tumor response to neoadjuvant systemic treatment, particularly as clinicians look to tailor therapies towards individuals with breast cancer. Patients with ER-/PR- tumors and patients with Her-2/neu+ tumors treated with trastuzumab were more likely to achieve pCR with a low rate of LRR after neoadjuvant chemotherapy, surgery, and XRT. However, the overall pCR rate still remains low, and further studies of alternative agents and regimens are needed to optimize outcomes in patients with breast cancer.

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2067 Optimal Time for Initiation of Accelerated Partial Breast Irradiation (APBI) using 3-D Conformal Radiotherapy (3D-CRT) - Preliminary Analysis of CINJ 040801

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Purpose/Objective(s): 3D-CRT is the most widely and available form of APBI used in the United States; it provides improved dose homogeneity compared to other APBI techniques, theoretically leading to improved cosmetic outcomes. However, the target volumes in 3D-CRT are highly dependent on the volume of the seroma after surgery and the optimal timing of APBI with respect to surgery has yet to be determined.