supine position compare to prone position. Furthermore, the maximum and mean dose to the ipsilateral lung and heart was lower in prone position compare to supine position.

Conclusion: Irradiation of patients in prone positions compare to supine positions did not improved dose distribution within target volume. Using plans generated in prone position we were able to reduce the dose to the organ at risk especially ipsilateral lung and heart.

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Titanium clip placement to allow accurate tumour bed localisation following breast conserving surgery – audit on behalf of the IMPORT Trial Management Group

C.E. Coles[1], G.C. Wishart[2], J. Cumming[1], J. Benson[2], P. Forouhi[2], C.B. Wilson[1], J.S. Wilkinson[1], R. Sharma[1], J. Yarnold[3]. *[1]Addenbrooke's Hospital, Oncology Centre, Cambridge, United Kingdom; [2]Addenbrooke's Hospital, Cambridge Breast Unit, Cambridge, United Kingdom; [3]Royal Marsden Hospital, Academic Department of Radiotherapy, Sutton, United Kingdom*

Background: Accurate tumour bed (TB) localisation is a key requirement for the national IMPORT LOW (Intensity Modulated Partial Organ Radiotherapy) trial testing risk-adapted radiotherapy (RT). We audited the use of titanium clips for TB localisation in breast RT planning.

Methods: Audit standards were set as follows: (i) 5/6 pairs of clips identified on RT planning computed tomography (CT) scan – 100%; (ii) possible clip migration – <10%; (iii) TB localisation improved with clips – >50%. At surgery, paired clips were positioned around the TB as follows: 1. Medial, lateral, superior & inferior: half-way between skin & fascia; 2. Deep: midpoint, usually the pectoral fascia (posterior); 3. Anterior: close to the suture line, avoiding skin dimpling. 30 consecutive patients with clips inserted were audited at the time of the RT planning CT scan.

Results: The median time from surgery to RT planning CT was 29 days (range 17 to 98 days). The TB could be successfully identified using CT seroma alone in only 8/30 (27%) patients. However, the titanium clips gave additional information for the remaining cases, and thus improved TB localisation around 22/30 (73%) of patients. There was no evidence of clip migration in any of the cases. TB localisation modified field borders in 18/30 (60%) patients. 5 of these patients had clearly defined seromas, so the addition of clips modified field borders in 13/30 (43%) patients (7 left and 6 right breast cancers).

Conclusion: Titanium clips provide an accurate and reliable method of TB localisation. The CT seroma cannot be used alone for TB localisation in the majority of patients. Accurate TB localisation is important for standard whole breast radiotherapy, as well as being essential for planning the RT boost and for partial breast RT. We anticipate that the audit results will lead to clips being adopted as best practice by the Association of Breast Surgeons at BASO (British Association of Surgical Oncology).

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A multidisciplinary approach to boost the breast tumor bed in 8 phases

Y. Kirova[1], N. Fournier-Bidoz[1], V. Servois[2], F. Laki[3], R. Salmon[3], R. Dendale[1], M. Bollet[1], F. Campana[1], A. Fourquet[1]. *[1]Institut Curie, Radiation Oncology, Paris, France; [2]Institut Curie, Radiology, Paris, France; [3]Institut Curie, Surgery, Paris, France*

Purpose: To describe a new procedure for breast radiotherapy (RT) that will improve tumor bed localization and RT treatment using multidisciplinary approach.

Patients and methods: This pilot study was conducted by the department of radiation oncology, surgery and radiology. A new procedure has been implemented summarized into 8 phases from pre-surgery contrast CT to surgery, tumor bed planning treatment volume (PTV) determination and lastly breast and tumor bed irradiation.

Results: Twenty patients (pts) presenting T1N0M0 tumors were enrolled in the study. All patients underwent lumpectomy with the placement of surgical clips in the tumor bed region. During the surgery, 1 to 5 clips were placed in the cavity of lumpectomy before the plastic procedure. All patients underwent their pre- and post operative CT scan in treatment position. The 2 sets of images were registered using a match-point registration. All volumes were contoured and the results were evaluated. The PTV was including: the clips region, the gross tumor volume (GTV) and the surgical scar, with an overall margin of 5−10 mm in all directions corresponding to localization and set-up uncertainties. For each patient the boost PTV was discussed and compared to our standard forward planned PTV.

Conclusion: We have demonstrated here the feasibility using multidisciplinary approach of a tumor bed localization and treatment procedure which seems adapted to routine practice. The use of more than one clip associated with a pre to post operative CT image registration allows a better definition of the PTV boost volume.

Table 1: Tumor bed localization and treatment workflow

Phase	Actors	Week
I – Pt's selection	Surgeon, Radiation oncologist	−2
II – Pre-surgery CT scan	Radiologist, Radiation oncologist RT technologists	−1
III – Surgery with placement of clips	Surgeon	0
IV – Post-operative CT scan	Radiologist, Radiation oncologist RT technologists	+4
V – Pre-to-post surgery CT registration	Dosimetrist	+4
VI – Volume delineation	Radiation oncologist	+4.5−5
VII – Treatment volume definition	Radiation oncologist	+4.5−5
VIII – Treatment planning	Dosimetrist, Physicist, Radiation oncologist	+5.5−6

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Voluntary deep-inspiration breath-hold radiotherapy for left sided breast cancer patients – first clinical results of a fluoroscopy guided method with retrospectively dose calculation

G.R. Borst[1], P.E. Elkhuizen[1], A. Betgen[1], D. Minkema[1], N.S. Russell[1], A. Giersbergen[1], H. Bartelink[1], C. van Vliet-Vroegindeweij[1], J.J. Sonke[1]. *[1]Antoni van Leeuwenhoek Ziekenhuis, Radiotherapy, Amsterdam, The Netherlands*

Background: Heart related death is observed at long term follow up for left sided irradiated breast cancer patients. Breath hold (BH) position creates a larger distance between the thoracic wall and the heart and reduces the irradiation dose to the heart. We developed a fluoroscopy guided voluntary deep-inspiration breath-hold (DIBH) radiotherapy (RT) treatment protocol.

Methods: RT planning for the breast or thoracic wall was performed in BH position. Prior to irradiation a Cone-Beam CT scan (CBCT) was acquired and used for patient setup. During irradiation the BH position was guided by kV (kilovoltage) fluoroscopy, visually validating alignment of ribs and diaphragm. In addition, images of the treatment field were acquired using the megavoltage (MV) photons of the irradiation. kV and MV images were used to retrospectively analyze the actual set-up error and stability during irradiation.

The total delivered dose to the breast or thoracic wall and to the heart, left ventricle, left anterior descending artery (LAD) and the lungs were calculated by accumulating dose distributions for each field and fraction whereby the observed position errors were taken into account. The dose in BH position was compared to the dose planned on the free breathing (FB) CT scan.

Results: To date, 10 patients were incorporated within this protocol.

The intra-fractional reproducibility of the BH position is high and the localization accuracy was about 2 mm (1SD) systematic and random. By introducing these errors into the delivered dose no decrease compared to the planned dose was observed for the volume of the breast which received more than 95% of the prescribed dose ($p > 0.05$).

The maximum heart distance within the irradiation field was reduced from an average of 1.6 cm to 0.2 cm ($p < 0.001$).

DIBH reduced significant the mean and maximum dose to the heart, left ventricle and the LAD compared to the planned dose on the FB scan. The mean lung dose was not significant different between the BH irradiation and FB planning

Conclusion: First clinical results of online CBCT and fluoroscopy guided voluntary DIBH RT showed a high localization accuracy providing good coverage of the target area and a substantially decreases of dose to the heart, left ventricle and LAD.

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Dose received by the sentinel lymph node (SLN) clip – prospective comparative study of two radiotherapy (RT) techniques of breast irradiation

R. Dendale[1], Y.M. Kirova[1], A. Savignoni[2], C. Nos[3], J.N. Guglielmina[3], F. Laki[3], N. Fournier-Bidoz[1], M.A. Bollet[1], F. Campana[1], A. Fourquet[1]. *[1]Institut Curie, Radiation Oncology, Paris, France; [2]Institut Curie, Biostatistics, Paris, France; [3]Institut Curie, Surgery, Paris, France*

Background: SLN biopsy is now frequently used for breast cancer (BC) conservative treatment especially for small tumors. The purpose of this study is to evaluate the prophylactic dose received to the region of SLN, marked by clip.

Methods and Materials: Between August 2001 and April 2004, for 152 patients (pts), who underwent a lumpectomy with SLN biopsy followed by

whole breast (WB) irradiation at the Institut Curie for early BC, a titanium clip was placed (during the surgery) at the zone where the first SLN was found. All pts were irradiated using previously published techniques: in dorsal decubitus (DD) position using 2 tangential fields and isocentric lateral decubitus (ILD). Prophylactic dose to SLN (PD) was defined as 95% of total dose prescribed to the breast (boost to tumor bed was not considered). The dose was evaluated to this "clip point". Prospective registration and dosimetric study was conducted in all cases. Statistical analysis used Student and chi 2 tests to find any correlation between anatomical, clinical and radiological pts' and tumors' characteristics and dose received to SLN bed.

Results: All 152 pts were enrolled in the study. The median age was 57 years (yrs) (34−81). The median weight was 60 kg (43−80). The median body mass index (BMI) was 23 kg/cm^2 (17−40). T1 98%, T2 2%, N0 93% and N1 7% of cases. All tumors were pN0. Sixty-eight percent were treated in DD and 32% in ILD position. The median total dose delivered to the WB was 50 Gy (32−54). For the population of all pts, PD was seen in 25% of cases, of them 17% of pts, treated in DD and 41% in ILD groups ($p = 0.018$). PD was found more often in young pts ($p = 0.04$), heavy pts ($p = 0.03$), pts with a higher BMI (0.03), and N2 ($p = 0.004$).

Conclusions: In our series we found that the dose received by the SLN clip is related to treatment position and pts morphology. These parameters could be systematically considered especially if an axillary node irradiation is proposed.

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The role of IMRT in the irradiation of breast cancer

H.D. Weinhold[1], J. Metz[1], U.H. Ricksgers[1], K. Muskalla[1]. [1]*Praxis für Strahlentherapie, Bergisch Gladbach, Germany*

Background: Breast cancer is one of the most frequent indications in radiation therapy. With common techniques the recommended range of the prescribed dose between 95% and 107% can not be realized in either case. Complex target volumes e.g. including axillary, supraclavicular or internal mammary lymphnodes are in most cases not covered in accordance to international recommendations (ICRU 50 and 62). Therefore further irradiation techniques are eligible. Three different techniques are described and the dosimetric results are compared. Especially the option of the Intensity Modulated Radio Therapy (IMRT) is investigated.

Material and Methods: Three different techniques are compared in three different clinical situations. The irradiation of bilateral breast cancer, the irradiation of a thoracic wall including axillary and supraclavicular lymphnodes and the irradiation of the breast including an integrated boost. The techniques to be compared are the common tangential irradiation, the tangential irradiation with an additional field (forward planned field-in-field technique), and the IMRT. All treatment plans have been calculated with the Eclipse planning software (VARIAN), based on the AAA photon calculation algorithm. The definitions of target volumes and the evaluation of all plans were carried out in accordance with the German S3-Guidelines and the recommendations ICRU 50 and 62.

Results: Only in rare cases the common tangential irradiation can fulfill the ICRU criteria strictly. With the use of an additional field in the treatment of the breast and the thoracic wall, respectively, the ICRU criteria are more frequently applicable. A dose coverage of the supraclavicular lymphnodes can be realized by a radiation technique with opposing fields, however, comprising considerable normal tissue volumes outside the target volume. An appropriate dose conformity to the target volume can be realized with IMRT, preventing high doses outside the target volume.

Conclusions: In simple cases the traditional approach of tangential fields with or without an compensation field provides good results within the ICRU limits. For complex cases the use of IMRT techniques provides an improved conformal dose distribution to the target volumes. However, with IMRT the amount of normal tissue outside the target volume, that receives low doses, increases. With IMRT the delivery of an integrated conformal boost to the tumorbed and thereby a shortened overall treatment time can be realized.

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Anatomical, clinical and radiological delineation of target volumes in the radiotherapy planning of breast cancer: individual variability, questions and answers

P. Castro Pena[1], Y. Kirova[1], F. Campana[1], R. Dendale[1], M. Bollet[1], N. Fournier-Bidoz[1], A. Fourquet[1]. [1]*Institut Curie, Radiation Oncology, Paris Cedex 05, France*

Purpose: To evaluate the variability of anatomical and radiological delineation for breast cancer radiotherapy, as part of preparing of new techniques as tomotherapie and simplified IMRT and propose the solutions to improve the delineation procedure.

Material and Methods: First phase: a patient with complete response after neoadjuvant chemotherapy, stage T3N3M0 breast cancer underwent CT scan in treatment position before radiation treatment was studied. Eleven radiation oncologists (5 breast cancer specialists and 6 residents in training program) independently delineated the breast and lymph node regions before the definition of target volumes. All regions [breast, axilla, supraclavicular lymph nodes (LN), infraclavicular LN, internal mammary chain (IMC)] were delineated and compared with regard to volume. The results were evaluated and the second phase consisted of training in contouring of treatment volumes for all physicians, then contouring of new patient: bilateral T1N0M0 breast cancer after conserving surgery and chemotherapy before radiation therapy.

Results: The clinical and radiological variations were observed between different radiation oncologists. After training in the volume delineation, the same physicians improved the contouring of different volumes. After the second phase there were still found differences some volumes. Simplified rules of volume delineation were established and atlas developed.

Conclusions: Major differences in anatomical and radiological delineation for breast cancer radiotherapy were observed between different physicians. This study conducted to development of written protocols of delineation. After training program, better results were observed. The study is still running with evaluation of dosimetric impact and definition of different target volumes.

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Results of a novel weekly fractionation regimen for brain metastasis in patients with carcinoma breast

A. Munshi[1], C. Srinivas[1], R. Jalali[1], A. Budrukkar[1], R. Sarin[1], K.A. Dinshaw[1]. [1]*Tata Memorial Hospital, Radiation Oncology, Mumbai, India*

Background: Breast cancer commonly metastasizes to bone, liver, lung and brain. The usual treatment of brain metastasis is whole brain radiotherapy to a dose of 20 Gray in 5 fractions or 30 Gray in 10 fractions. We attempted to study a novel weekly fractionation regimen for brain metastasis in patients with carcinoma breast.

Material and Methods: 40 consecutive patients of breast cancer with brain metastasis were taken in this prospective study. In all patients baseline characteristic were recorded before radiotherapy. A dose of 12 Gray in 2 fractions (1 week apart, on Saturdays) was delivered to whole brain by German helmet technique using Cobalt 60 machine or a 6 MV linear accelerator. A parallel pair technique was used for this purpose. A clinical evaluation was done before radiotherapy and at RT conclusion. Patients who did not report for follow up were contacted on phone or by letters to accurately assess the status and overall survival.

Results: The mean age was 49 years (range 31−72). 23 (57.5%) cases underwent CT while the rest underwent MRI examinations for detection of brain metastasis. 9 (22.5%) patients had a single lesion and 30 (75%) had multiple lesions. One patient had diffuse leptomeningeal involvement. Only 2 patients (5%) were taken for surgery for the metastatic brain lesion while the rest underwent upfront radiotherapy. 28 patients (70%) felt better, 10 (25%) felt same as before while 2 (5%) felt worse at radiotherapy conclusion. At one month 32 patients (80%) had improved or stable KPS while 8 patients (20%) had decreased KPS. The median survival of the patients was 6.5 months.

Conclusion: Our novel fractionation regimen has shown equivalent survival rate compared to more fractionated regiments. This treatment is a useful resource sparing strategy for busy oncology centers and reduces patient visits to the hospital.

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Breast cancer patients treated with intra-operative radiotherapy alone when conventional external beam radiation therapy was not possible

M. Keshtgar[1], J.S. Tobias[2], J.S. Vaidya[3], C. Stacey[4], T. Corica[5], D. Joseph[5], A. Keller[6], F. Wenz[6], N.R. Williams[7], M. Baum[7]. [1]*Royal Free Hospital, Department of Surgery, London, United Kingdom;* [2]*UCLH, Department of Radiotherapy, London, United Kingdom;* [3]*Ninewells Hospital & Medical School, Department of Surgery, Dundee, United Kingdom;* [4]*UCLH, Department of Medical Physics, London, United Kingdom;* [5]*Sir Charles Gairdner Hospital, Department of Radiation Oncology, Perth, Australia;* [6]*Universitätsklinikum Mannheim, Universitätsklinik für Strahlentherapie und Radioonkologie, Mannheim, Germany;* [7]*UCL, Department of Surgery, London, United Kingdom*

Background: Intra-operative radiotherapy (IORT) with Intrabeam system has been piloted since 1998 and used in the randomised TARGIT International trial since 2000. Some patients are suitable for off-trial therapy,