OC-0192: The development of a device to immobilise the breast during radiotherapy: The SuPPORT 4 All project

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Material and Methods
Twenty left-sided and 30 right-sided breast cancer patients requiring adjuvant WBI were treated on the crawl couch. At each treatment fraction, a cone beam computed tomography (CBCT) was performed to quantify patients' shifts in anteroposterior (AP), laterolateral (LL) and craniocaudal (CC) directions after positioning on the isocenter lines. Shifts along the 3 axes were analysed in R 3.4.1 and group systematic error (M), standard deviation from M (Σ) and the root mean square of individual standard deviations from the mean individual patient shift (σ) were calculated. LL shifts were inverted for left-sided patients so they didn't cancel out the LL shifts for right-sided patients. PTV margins were calculated according to Van Herk's formula . Data were then compared to published results for prone positioning in the literature.

Results
Results for M, Σ, σ and the calculated PTV margins along each axis are reported in table 1.

	AP	LL	CC
M	1.15 mm	-0.53 mm	-0.36 mm
Σ	2.78 mm	3.23 mm	3.82 mm
σ	3.64 mm	4.09 mm	3.58 mm
Calculated Margins	9.50 mm	10.94 mm	12.06 mm
Literature range for Margins	9.2 - 21.0 mm	9.6 - 34.7 mm	6.8 - 15.8 mm

Conclusion
When comparing our results to the published literature results, the margins calculated for positioning on the crawl couch are amongst the lowest reported for WBI in prone position, especially for the AP and LL axes. These findings illustrate the crawl couch's ability to minimize the existing positioning inaccuracies in prone positioning. The crawl couch allows for prone WBI with minimal CTV to PTV expansions in all directions. This reproducibility and accuracy is imperative in order to proceed to implementation of regional nodal irradiation in prone position. Next to the existing evidence from planning studies of WBI + regional nodal irradiation in prone position, this study lays the foundation for clinical investigation of WBI + regional nodal irradiation in this patient group using the crawl couch.

OC-0192 The development of a device to immobilise the breast during radiotherapy: The SuPPORT 4 All project

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Purpose or Objective
A support bra (S4A bra) has been designed for women who have undergone wide local excision of a breast tumour and require a course of adjuvant radiotherapy. The bra is designed to lift and hold the breast away from the chest wall aiding treatment planning, and delivery while improving patient dignity. The primary endpoint was a support bra that is technically acceptable to health-care professionals (HCPs) and aesthetically acceptable to patients.

Figure 1 Diagrammatic presentation of the S4A bra.

Material and Methods
The study adopted the Medical Research Council framework for developing and evaluating complex interventions. The first stage involved a participatory co-design methodology. Multiple workshops were held with patient representatives and healthcare professionals (HCPs) to seek understanding of the patient experience of the radiotherapy journey and the challenges experienced by HCPs in delivering treatment. Stage 2 involved phantom testing and testing on healthy volunteers (HVs) to confirm S4A bra accuracy and potential to reduce the dose to organs at risk. The final stage involves a clinical feasibility trial (n=50) to assess acceptability and functionality of the bra in the clinical setting.
To minimize bias we have adopted the following strategies throughout the different stages of the study:

- The workshops were audio recorded and transcribed verbatim.
- Data analysis used a systematic and iterative process with two researchers coding the transcripts independently and comparing codes. An agreed coding scheme was developed through discussion, and member-checking was used to ensure trustworthiness of the data.
- In the testing stage, multiple set-ups were conducted to replicate a treatment course in bra and no bra conditions.

Results
Participants provided feedback on the design of the prototype support bra that allowed refinements to enhance patient comfort and usability for both patients and HCPs. In addition, workshop participants defined their experiences (users) and challenges (HCPs) associated with the existing breast radiotherapy pathway. Phantom testing demonstrated the bra was able to accurately position the breast phantom (3D displacements of 1.5mm and 1.3mm for S4A bra and no bra conditions). The HV study utilised a non-invasive 3D surface scanning method and demonstrated the bra design lifts the breast away from the chest wall, which can aid treatment planning and potentially reduce the radiation dose received by organs lying close to the breast (such as the lung or heart). Reproducibility of the breast was comparable to published data from recent studies (Table 1).

Table 1 Accuracy Data from the HVS Compared with Published Data

	Random Error (mm)		
	Right-Left	Superior-inferior	Anterior-Posterior
ABC Breath Hold device Heartspare I data	3.8	3.3	2.6
vDIBH Heartspare I data (n=22)	2.4	4.1	2.7
vDIBH Heartspare Ib data (n=23)	1.9	2.6	3.5
Prone Heartspare Ib	5.4	4.5	4.6
S4A Bra Healthy Volunteer Study unpublished data(n=16)	2.5	2.1	3.0

Conclusion
The S4A bra has the potential to improve the overall patient experience. The co-design process facilitated the development of additional patient self-reporting tools to be used with the S4A bra to aid patient empowerment. Pre-clinical testing provided confidence that the S4A bra provides lift and hold of the breast that could assist HCPs in reducing the radiation dose received by OAR.

OC-0193 Optical surface scanner, indexed patient support and IGRT make skin markers obsolete in radiotherapy

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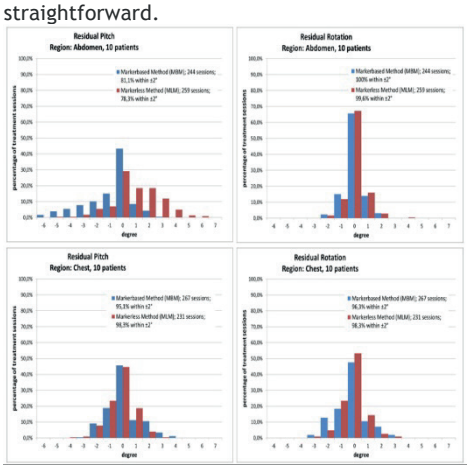
Purpose or Objective
In recent years, conformal treatment techniques fitting dose very close to the target for better sparing of adjacent normal tissue have become standard in radiotherapy. As treatment planning is usually based on one or very few snapshots of the anatomical relations, various IGRT concepts aim to meet the pre-treatment conditions during planning- CT for any single treatment fraction. However, uncertainties like patient deformation or rotation still influence the final accuracy and emphasize the importance of a consistent patient support. Many clinics still use markers on patient's skin and external lasers for the first positioning step applying a patient related coordinate system.
With our investigation, we suggest a different way of patient positioning based on an idea of [1] using an external coordinate system, i.e. absolute couch coordinates in combination with an optical surface scanner. We retrospectively compared the 'old" marker based method (MBM) with the new marker-less method (MLM) for 10 patients in each group in two anatomical regions (abdomen and chest) respectively.
Material and Methods
The new MLM consists of three steps:

1. Patient support (Omniboard, MacroMedics) is completely indexed to couch allowing the calculation of treatment table position depending on isocenter location. The support device is prepared and the patient placed on table.
2. The couch is moved to the calculated position and the optical surface scanner (Catalyst, CRAD) used to correct deformation and rotation.
3. IGRT is applied for final isocenter positioning based on bony anatomy (OBI, Varian Medical Systems).

The traditional MBM was performed using the identical (indexed) support device but the positioning was done according to tattoos on patient's skin and external lasers as common practice. Again, IGRT was used for final isocenter correction.
Based on orthogonal IGRT images the remaining pitch and rotation after each fraction were calculated and monitored for the two patient groups.

Results
Our investigation shows no significant difference between the two methods regarding the remaining rotational deviations, MLM performs slightly better for chest and inferior to MBM for abdomen, although not significantly (see image (1)). As both methods presume correlation between patient's surface and bony anatomy the final accuracy is still strongly patient-dependent. However, with treatment workflow and patient comfort in mind the MLM includes several advantages:

1. no skin markers required,
2. higher patient safety due to independent and consistent support device positioning,
3. deformations can be corrected efficiently using information of the surface scanner and
4. after a training period the workflow is fast and straightforward.



Conclusion
The presented new method (MLM) allows positioning of patients at least as accurate as the common used practice with skin marks. Our clinic is applying this method since 01/2016.
[1] Martens R et al. The workflow and benefits of patient positioning based on absolute table coordinates. ESTRO33 2014, Poster RTT track

OC-0194 Evaluation of an optical surface monitoring system for intrafractional movement during SABR

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Purpose or Objective
To evaluate the accuracy of a real time 3D optical surface imaging system for monitoring intrafraction motion during frameless stereotactic ablative treatment of spine, lymph node and non-spine bone metastases.
Material and Methods
Patients treated with SABR for spine, lymph node and non-spine bone metastases were immobilized in a comfortable and appropriate position to irradiate the metastatic lesion(s). Support devices were used to increase patient comfort and to ensure set-up reproducibility, but no thermoplastic body mask or dual vacuum system was used.
During each fraction, three CBCT scans were acquired; CBCT1 before treatment, CBCT2 after correction for