Results: The average differences in the anterior-posterior (AP), superior-inferior (SI) and lateral (LL) directions from CBCT were 0.25±0.53 cm, -0.08±0.52 cm, -0.16±0.57 cm for AP, SI and LL directions, respectively. Student’s t-test was used to test the difference between this US modality against CBCT and the distribution of the differences is reported in Figure 1.

Conclusion: Based on the obtained results, significant differences with CBCT were found in all directions. However, the average difference of the differences is always less than 3 mm in all directions. Differences greater than 1 cm were observed in the AP direction (5%) showing that CBCT imaging modality is not safely interchangeable with 3DUS.

EP-2115
Breast radiotherapy: comparison of set up error using All In One system and dedicated breast board
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Purpose or Objective: The aim of this study was to determine whether proper selection of fixation equipment has positive effect on the reduction of setup error for breast radiotherapy.

Material and Methods: The study has been performed on 10 breast cancer patients positioned on All In One system, and 10 patients treated using dedicated breast board. Selected patients represent average breast cancer patients. Patients with special setup needed, were excluded. (eg. patients with reduced arm mobility, patients with large contra lateral breast etc.). On both fixation systems the same setup protocol was used. Imaging and setup correction were performed on fractions 1, 2, 3, 8, 13, and every 5th further fraction. All the correction data were written in specially prepared forms. All the data collected were entered in excel worksheet, and further analyzed.

Results: The results showed that All In One system had standard deviation of set up error 0.31 cm in sagittal axis, 0.3 cm in longitudinal axis, and 0.36 cm in coronal axis. Compare to that, standard deviations of setup error for dedicated breast board were: 0.28 cm in sagittal axis, 0.24 cm in longitudinal axis, and 0.24 cm in coronal axis.

Conclusion: The result showed that usage of dedicated breast board offers better setup precision, especially in coronal axis. This can be due to more rigid construction of dedicated breast board, compare to foamy structure of All In One system. However, this difference is not so big to completely exclude usage of All In One system, especially in situations where his comparative advantages makes him a fixation of choice. Also, this was relatively small sample of patients, so further study should be performed.

EP-2116
Optimization of whole breast irradiation setup: comparison between two different positioning systems
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2Università Campus Bio-Medico, Radiation Oncology Unit, Rome, Italy

Purpose or Objective: A precise and reproducible patients’ setup, within established thresholds, may lead to a reduction of time spending in breast radiotherapy treatment positioning, and highly precision in targets irradiation, sparing organs at risk (OAR). The aim of this study is to compare two different breast positioning systems.

Material and Methods: Overall 278 portal images film were analyzed with EPID system, for a total of 40 female patients treated with tangential fields breast RT. EPID acquisitions were made in two different Italian University Centers. Twenty patients were treated with a supine positioning on a 12.5 degrees inclined breast board, while 20 patients were treated with supine positioning using a wing board. Each EPID imaging couple were acquired weekly using medial and lateral tangential fields. Images were newly acquired in case of 5 mm error shift. The EPID images were subsequently compared to the referring DRR, using the three spatial axes: X (lateral), Y (longitudinal), and Z (vertical). The systematic and random errors of the two different studied groups were then calculated.

Results: Breast board system showed a systematic error of Σ-1.41 mm on the X, 2.23 mm on the Y, and 1.69 mm on the Z axis; the median random error was 0.3 mm, 0.46 mm and 0.36 mm, respectively. Concerning the wing board system, the systematic errors were Σ-3.34 mm on the X, 3.12 mm on the Y, and 2.68 mm on the Z axis; with random errors of 0.63 mm, 0.6 mm, and 0.53 mm, respectively.

Assuming as acceptable the shift with a maximum threshold of 5 mm, it was possible to calculate the probability of setup accuracy. It was 99% on the X, 94% on the Y, and 97% on the Z axis, using the breast board setup; while it was 91%, 86%, and 88% using the wing board system.

Conclusion: Since the small sample series, these data should be interpret with caution. Preliminary results of our analyses showed an high accuracy sensitivity for both setup approach. However a better accuracy in favor of the breast board positioning system was shown.

EP-2117
Is Rotational shifts necessary in SBRT? A geometric analysis using a 6-degree of freedom(6-DoF)couch
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1Università Cattolica del Sacro Cuore, Radiation Oncology Department- Gemelli-ART, Rome, Italy
2Università Cattolica del Sacro Cuore, Physics Institute & Operative Unit of Medical Physics, Rome, Italy

Purpose or Objective: To study the relevance of rotational shifts using 6DoF robotic couch in patients treated with stereotactic body radiation therapy(SBRT)to improve setup accuracy.

Material and Methods: Patients affected by primary or metastatic lung tumours with a diameter until 5 cm were enrolled to SBRT. Breast board(CIVCO support system) was used for set-up of supine patient in all phases of treatment. Gross target volume was defined by a radiation oncologist on 4D TC scan. Treatment planning was carried out with Eclipse™ Treatment Planning Systems (Varian Medical System), Palo Alto, CA) and Volumetric arc therapy was used. Total dose was prescribed on the basis of tumours position and dimensions: 42 Gy in three fractions, for lesions with diameter smaller than 3 cm, or 50 Gy in five fractions, for lesions between 3 and 5 cm. Daily Cone Beam Computed Tomography(CBCT) was performed before dose delivery. Then images were compared with CT scan for radiotherapy planning(automatic and manual 3D-3D match) in order to determine the magnitude of set-up error and organ motion: translational(Lateral, Vertical and Longitudinal) and rotational(Pitch, Yaw and Roll) shifts were identified(Varian 6D Online Review System). The collected shifts were applied...
on the Protura TM Robotic couch 6DOF to obtain a more accurate alignment. Mean translational and rotational shifts were calculated.

Results: From July to September 2015, 13 patients were enrolled (10 with primary lung tumours and 3 with metastatic lung lesions) with a median age of 74 yrs (range 58-86). Fifty-two CBCT were performed and compared to CT images. The mean (±SD) interfraction displacements in all DoF are reported in Table 1.

<table>
<thead>
<tr>
<th>Lat (cm)</th>
<th>Vrt (cm)</th>
<th>Lng (cm)</th>
<th>Roll (deg)</th>
<th>Pitch (deg)</th>
<th>Yaw (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>0.04</td>
<td>-0.13</td>
<td>0.04</td>
<td>0.16</td>
<td>-0.04</td>
</tr>
<tr>
<td>ST.DEV.</td>
<td>0.40</td>
<td>0.39</td>
<td>0.57</td>
<td>1.21</td>
<td>1.21</td>
</tr>
<tr>
<td>MAX</td>
<td>0.95</td>
<td>1.12</td>
<td>1.64</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>MIN</td>
<td>-0.64</td>
<td>-0.79</td>
<td>-1.50</td>
<td>-3.70</td>
<td>-2.00</td>
</tr>
</tbody>
</table>

The mean (±SD) 3D vector of displacement was 0.7 ± 0.4 cm. The maximal translation setup shift was 1.1 cm vertically, 1.6 cm longitudinally and 1 cm laterally, with 77% of the shifts < 3 mm. The maximal rotation error was +3° for Pitch, -3.7° for Roll and -3.4° for Yaw, with 22% of the rotations >1° and 3 mm laterally, with 77% of the shifts < 3 mm. The maximal rotation setup shift was 1.1 cm vertically, 1.6 cm longitudinally and 1 cm laterally, with 77% of the shifts < 3 mm. The maximal rotation setup shift was 1.1 cm vertically, 1.6 cm longitudinally and 1 cm laterally, with 77% of the shifts < 3 mm.

Conclusion: This work confirms that a 6-DoF robotic couch could be useful to improve accuracy in IGRT era, especially in SBRT. No correlation was found between translational and rotational errors, but it could revealed important outliers and corrected. Geometric and dosimetric analysis on other regions are on going.

EP-2118
CBCT in stereotactic body radiation therapy for lung tumors: manual matching versus auto-matching
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2University of Florence, Department of biomedical-experimental and clinical sciences "Mario Serio", Florence, Italy

Purpose or Objective: To correlate manual matches performed by radiation therapy technologists (RTTs) with two modality of automatic matching ("Bone match" and "Grey value match"). The manual alignment is taken as the gold standard mode and the purpose is to check the deviation between the values of translation and rotation obtained by this alignment and the values detected with the two types of automatic matching.

Material and Methods: This study included 10 central lung lesions treated with three sessions of SBRT, 18 Gy per fraction. 4DCT was used. The gross tumor volume (GTV) was defined on average reconstruction (AVG) and the internal target volume (ITV) was obtained modelling the GTV on the secondary images (MIP: maximum intensity projection). Planning Target Volume (PTV) was obtained adding 0.5 cm of margin to the ITV. For each session values of translation and rotation along the three axes (x, y, z) were collected off line by performing three different registrations: manual match only on the target, bone match and grey value match using a clip box containing a vertebral body and closest bone structures. Values of manual alignment were collected by three RTTs for a total of 9 images comparisons for each patient and a mean manual alignment was assessed and compared to the values of the automatic alignments. Table 1 shows an example of collected data related to one of the patients.

Table 1

<table>
<thead>
<tr>
<th>Lat (cm)</th>
<th>Vrt (cm)</th>
<th>Lng (cm)</th>
<th>Roll (deg)</th>
<th>Pitch (deg)</th>
<th>Yaw (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
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<td>0.04</td>
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<tr>
<td>ST.DEV.</td>
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<td>1.64</td>
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</tr>
<tr>
<td>MIN</td>
<td>-0.64</td>
<td>-0.79</td>
<td>-1.50</td>
<td>-3.70</td>
<td>-2.00</td>
</tr>
</tbody>
</table>

Results: The results are summarized in the table 2. About translations: gray value matching fails in all sessions of subject 5 (affected by pleural effusion), bone matching fails in the second session of the subject 4 and both have errors slightly high in the subject 8. About rotations: gray value matching fails in all sessions of subject 5 and in the first session of the subject 2. The bone shows difficulty in subjects 4, 9 and 10.

Table 2

<table>
<thead>
<tr>
<th>Subject</th>
<th>Translation X</th>
<th>Translation Y</th>
<th>Translation Z</th>
<th>Rotation Roll</th>
<th>Rotation Pitch</th>
<th>Rotation Yaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.5</td>
<td>0.3</td>
<td>-0.8</td>
<td>3.0</td>
<td>-2.5</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>-0.4</td>
<td>0.2</td>
<td>-0.7</td>
<td>2.9</td>
<td>-2.4</td>
<td>1.1</td>
</tr>
<tr>
<td>3</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.6</td>
<td>2.8</td>
<td>-2.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Conclusion: The study shows that in some particular pathological cases, such as pleural effusion and atelectasis, automatic method could be not accurate. In these it was found that the bone matching values are the closest to the gold standard values. In particular in four cases there was a significant difference between the manual and the automatic alignments, it could result in a not tolerable location of the target before and during the treatment. The results could be conducted to the difference in the breathing in the different sessions, a larger PTV in some selected patients could guarantee an higher precision in treatment delivery.

EP-2119
A clinical investigation of optimal CBCT image matching for non-SABR radical lung cancer patients
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Purpose or Objective: Spine-based image registration has traditionally been used for patient setup for non-SABR radical lung cancer radiotherapy. Enhanced visualisation of soft tissue structures through volumetric imaging has led to research of various landmarks that may offer target localisation of increased accuracy compared to spine-based registration. The objectives of this project were to answer the following: Can using carina or tumour as registration landmarks for IGRT offer superior target coverage compared to spine registration? Does the position of tumour affect which registration landmark offers superior target coverage? What are the implications of carina or tumour registration on spinal cord safety?

Material and Methods: Ten patients with central tumours and ten patients with peripheral tumours were selected. A clinical expert assessed a sample of CBCTs from each patient and selected which thoracic landmark (spine, carina, or tumour) produced the the optimal match. CBCTs from each patient (238 CBCTs in total) were matched using the spine and the optimal match and translational displacements were recorded. The difference between the spine-match displacements and optimal-match displacements were