transverse preoperative series and, respectively, 12 and 15 postoperative scans. The median P95 was 1.2 mm or smaller, for all orientations (table 1). High values up to 6.6 mm were found in only three patients during short, deep aspiration. Regular breathing was observed in the other scans. No differences were found between pre- and post-BCS situations (p > 0.05).

<table>
<thead>
<tr>
<th></th>
<th>Preoperative (n=20)</th>
<th>Postoperative (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P95, AP (mm)</td>
<td>1.0 (0.5–6.6)</td>
<td>1.0 (0.4–4.9)</td>
</tr>
<tr>
<td>P95, CC (mm)</td>
<td>0.9 (0.3–4.4)</td>
<td>0.9 (0.3–4.1)</td>
</tr>
<tr>
<td>P95, LR (mm)</td>
<td>0.6 (0.2–3.1)</td>
<td>0.6 (0.4–1.0)</td>
</tr>
</tbody>
</table>

Table 1: The P95 parameter of the breast and CTV in all 3-plane directions and for all patients, from both preoperative and postoperative core-CT1 scans. Values are shown as median (range).

Conclusions: Intra-fraction breast and CTV motion is limited, before and after BCS, in supine RT position. This is essential for safe delivery of new hypofractionated RT treatments. Further research is planned to analyse intrafraction motion on a longer time scale.

PO-0922
Management of intra-fraction motion in prostate radiotherapy: a study of 100 patients imaged for all fractions
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Purpose/Objective: Several approaches are used in clinical practice for the management of prostate intra-fraction (i-f) motion. They range from using historically based standard PTV margins to the use of population margin recipes based on determined or published errors. We investigated the effectiveness of such methods based on a large study of all treatment fractions for 100 prostate patients undergoing radiotherapy at our institution.

Materials and Methods: Pre and post-treatment kV orthogonal images were collected for a total of 3559 treatment fractions. From this dataset we determined and characterised i-f motion and evaluated the effectiveness of the differing margin approaches to account for all patients within the study group. Strategies for the effective management of all patients within the study population were formulated.

Results: The mean (StdDev) i-f motion from all observations is -0.07 (0.21), 0.07 (0.20), -0.01 (0.16) cm for the AP, SI and LR directions respectively. A derived population margin to cover 90% of patients with 95% dose is 0.52, 0.50, 0.42 cm for AP, SI, LR respectively. Extending the margin to cover 99% of patients with 95% dose requires a further increase of 0.15 cm which is similar to our institutional isotropic margin of 0.7 cm.

Six patients from our study group had i-f displacements > 0.52 cm for >10% of treatment fractions. The mean (StdDev) for this subgroup is -0.33 (0.24), 0.22 (0.21), 0.05 (0.19) cm in the AP, SI and LR directions respectively. A derived population margin to cover 90% of patients with 95% dose is 0.52, 0.50, 0.42 cm for AP, SI, LR respectively. Extending the margin to cover 99% of patients with 95% dose requires a further increase of 0.15 cm which is similar to our institutional isotropic margin of 0.7 cm.

Conclusions: We have identified a subgroup of patients that display a significant post-inf directional displacement during treatment that is inadequately managed by an isotropic margin approach. Ideally these would be identified early in the treatment course to allow for proactive management. In considering a management strategy to afford optimal margins without compromising cover; whilst imaging for the first few fractions is clearly shown to be of benefit, our findings support the argument for real time tracking in prostate radiotherapy especially where posterior PTV margin reduction is used as a strategy for improving rectal sparing.

PO-0923
Intra-fraction motion of the prostate is a random walk
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Purpose/Objective: Intra-fraction motion of the prostate can be a limiting factor to the quality of delivery of external beam radiotherapy. According to the 'random walk'
hypothesis, the intra-fraction positions of the prostate are not independently distributed. Rather, the prostate follows a continuous path where each position is strongly correlated to its previous position. In this study, the random walk hypothesis was prospectively tested, parameters of the motion were determined, and implications for intra-fraction motion management were explored.

**Results:** Intra-fraction motion of the prostate was best described as a stochastic process with an auto-correlation coefficient of $R^2 = 0.92 \pm 0.13$. The random walk hypothesis ($R^2 = 1$) could not be rejected ($p = 0.27$). The static noise hypothesis ($R^2 = 0$) was rejected ($p < 0.001$). The Dickey-Fuller test rejected the null hypothesis $R^2 = 1$ in 25% to 32% of cases. On average, the Kwiatkowski-Phillips-Schmidt-Shin test rejected the null hypothesis $R^2 = 1$ with a probability of 93% to 96%. The variance in prostate position increased linearly over time ($R^2 = 0.9 \pm 0.1$). There was substantial variability in motility between fractions and patients with maximum variance increases with time, such that shorter fractions are more independent than longer fractions. Therefore, the margin for pelvic nodes is $2.4 \text{ mm}$, $3.4 \text{ mm}$ and $4.9 \text{ mm}$ in lateral, longitudinal and vertical directions, and these values only depend on the prostate+patient intrafraction motion uncertainties. Howeve r, following our protocol arrangement (7 fields equally-spaced in our protocol), the PTV (prostate) margin is $3.1 \text{ mm}$, $3.4 \text{ mm}$ and $4.9 \text{ mm}$ in lateral, longitudinal and vertical directions, and these values only depend on the prostate+patient intrafraction motion (PTV delineation uncertainty has not been taken into account).

Since we use implanted markers registration, the margin of the pelvic nodes is greater than the previous margin. In order to calculate the margin of the pelvic nodes, we have included the relative motion between bone and fiducials and the intrafraction motion of the patient only (not the prostate) uncertainties. Therefore the margin for pelvic nodes is $2.4 \text{ mm}$, $7.7 \text{ mm}$ and $6.3 \text{ mm}$ in lateral, longitudinal and vertical directions.

**Conclusions:** Our protocol allows us to reduce considerably the PTV margin in the prostate. However the significant motion observed between markers and bone in several patients forces us to keep a high pelvic nodes margin. On the other hand, it is important to distinguish between prostate+patient intrafraction motion and patient motion and use the latter to calculate the pelvic nodes margin. Otherwise, this margin would be overestimated.

**Materials and Methods:** Twenty four patients were imaged and 1177 pairs of stereoscopic images were used in this study. 17 of these 24 patients were implanted four gold seeds in the prostate and were enrolled in our daily protocol.