Factors affecting patient intra-fraction analysis during free-breathing breast cancer radiotherapy

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Objective

In this study, we retrospectively analysed SGRT signal on a large cohort of breast cancer patients investigating treatment factors (inter-fraction error, treatment session time and fraction number) affecting intra-fraction accuracy.

Material and Methods

Figure 1. Graphical study design.

Glossary

Magnitude (MAG): square root of the sum of the squared vector components (VRT, LNG, LAT).
Intra-fraction mean error (mean error): average drift of SGRT signal during beam-on-time of each session.
Intra-fraction maximum error (max error): difference within 10-90 percentiles of SGRT signal during beam-on-time of each session.
Population mean/maximum errors (pop mean/max error): average over the population of mean/maximum errors for MAG. Values are reported as mean ± 1SD.

Analysis

For each group, mean and max errors were correlated with treatment session time (<2, 2-3, 3-4, >4 minutes) and with the fraction number (between 1st and 13th). Anova test was used to assess correlations.
Differences between intra-fractions errors for well- and bad-setup were assessed with chi-square test. Statistically significance was set to p<0.05.

Results

Considering well-setup group (278 patients, 1677 fractions), the pop mean error was 2.1 ± 1.3 mm, while the pop max error was 1.9 ± 2.0 mm. Considering bad-setup group (88 patients, 723 fractions), the pop mean error was 2.2 ± 2.4 mm, while the pop max error was 2.5 ± 6.1 mm.
Figure 2 shows the percentage of fractions with a mean and max errors higher than 5 mm, for well- and bad-setup.

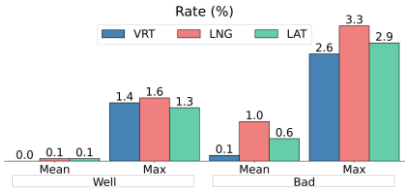

Figure 2. Barplot representing the percentage difference between the fractions with errors ≤ 5 mm and errors > 5 mm.

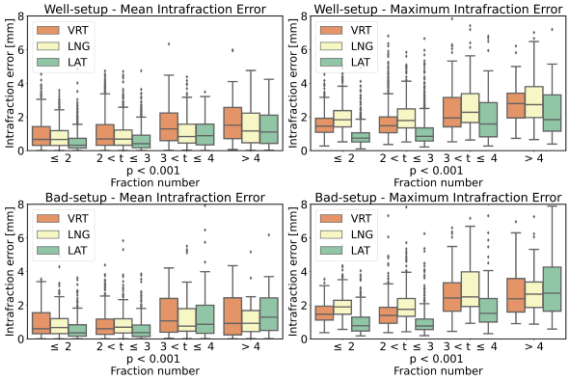

Figure 3. Boxplot of intra-fraction as a function of treatment time for each group. Anova test confirms an increase of intra-fraction error with session time in all groups.

Figure 3 shows intra-fraction errors over the three directions as a function of treatment time for each group. Figure 4 shows the intra-faction errors as a function of fraction number for each group.
The difference between well- and bad-setup resulted statistically significant for MAG with the chi-square test (p=0.003 and p=0.008 for mean and max error, respectively.

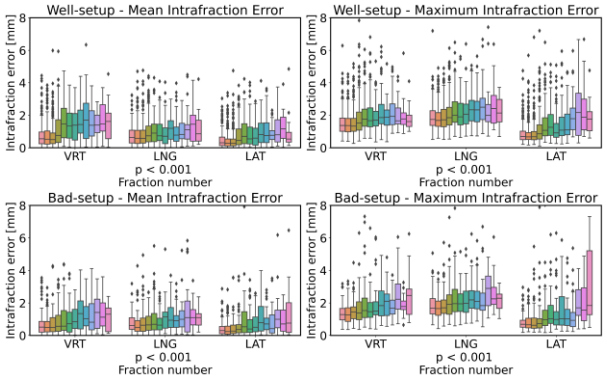

Figure 4. Boxplot of intra-fraction errors as a function of fraction number (between 1st and 13th) for all datasets. Anova test confirmed a significant correlation between intra-fraction error and treatment fraction number for all groups analysed.

Conclusion

Our analysis showed that large inter-fraction errors (bad-setup patients) are correlated to significant intra-fraction errors.
Intra-fraction mean and max errors were found to increase with treatment time. In addition, a slight dependence of intra-fraction errors was observed as the number of treatment fractions increased.