Purpose or Objective: In head and neck cancer radiotherapy, it is still unresolved whether the use of daily image guidance (IG) allows the safe adoption of reduced PTV margins. Moreover, the extended time required for IG on a daily basis unavoidably represents a limiting factor for patients throughput in centers with busy workload. The purpose of our analysis is: 1) evaluating the interfraction error of patients undergoing tomotherapy for oropharyngeal cancer (OPC) with the aim of margins reduction and 2) investigating whether the mean error calculated on the first 5 fractions may avoid the need of performing IG on a daily basis.

Material and Methods: A cohort of 20 OPC patients radically treated with tomotherapy was retrospectively analyzed. Conventionally, a 5-mm CTV to PTV margin policy was used. All patients underwent integrated mega-voltage computed tomography (MVCT) before every fraction and were treated after correction of shifts in the medial-lateral (X), supero-inferior (Y), and antero-posterior (Z) directions, as well as in the medial-lateral rotation (roll). These “on-line” variations were registered for every patient. In order to test the reproducibility of the procedure, for a subset of 10 patients (for a total of 301 MVCT’s) a “re-matching” was performed: shifts adopted at time of treatment were reset and a manual re-alignment was then blindly performed. Mean values and standard deviations were calculated and compared for the two sets of data. To test the hypothesis of the applicability of a mean-error strategy, the mean shifts calculated on the first 5 fractions were applied on the subsequent fractions and the mean residual error was evaluated.

Results: A total of 619 MVCT’s was analyzed. The mean X, Y, Z and roll errors for the 20 analyzed patients are reported in Figure 1.

The mean of the absolute X, Y, Z and roll errors were 1.8 mm, 3.4 mm, 2.4 mm, and 0.5° respectively. The mean “off-line” shifts were very similar to the “on-line” ones (as shown in Table 1).

The equivalence between the “on-line” and “off-line” shifts was extremely high (Pearson’s correlation coefficient, $p<0.05$), therefore further validating the integrity of the data. For the majority of patients the random component of the setup error was predominant, so the mean error strategy was not effective in reducing the setup error. Only in 5 cases a clear systematic component in the setup error was identified, which was effectively reduced with the application of the mean shifts.

Conclusion: The use of a reduced 3-mm PTV expansion margin can be safely implemented in the context of daily IG in OPC. On the other hand, in cases where a clear systematic component of the setup error is detected, the strategy of correcting for the mean error derived from the first 5 MVCT’s is efficient in reducing residual setup errors, possibly allowing the adoption of a non-daily IG policy in these cases.

Material and Methods: The stomach volume was outlined on the planning CT and 4 CBCT images taken over the course of treatment (first 3 fractions then once weekly) for 4 patients. Image registration between the planning CT and CBCTs was undertaken using the Velocity software package, with the quantification analysis of stomach movement and volume change being carried out in the CERR software environment using in-house Matlab scripts. The difference in maximum and minimum $x,y,z$ coordinates, change in centre of mass (COM) and total volume between each CBCT image and planning image for the stomach volume and PTV/stomach volume overlap was calculated.

Results: The mean and range of displacement across all image sets and patients for the maximum and minimum $x,y,z$ coordinates of the stomach was 5.4mm (0.0-23.4), 6.7mm (0.0-36.1) and 10.5mm (0.0-42.0), respectively. The mean and range of displacement for the COM $x,y,z$ coordinates across all image sets was 4.0mm (7.0-14.6), 3.3mm (1.0-11.7) and 8.7mm (1.0-31.4) respectively. The mean change in total stomach volume was 22.2% (0.4-64.5), whilst the authors’ best knowledge, this study is the first to quantify the stomach’s movement and volume change during radiotherapy using Cone Beam Computed Tomography (CBCT) images.