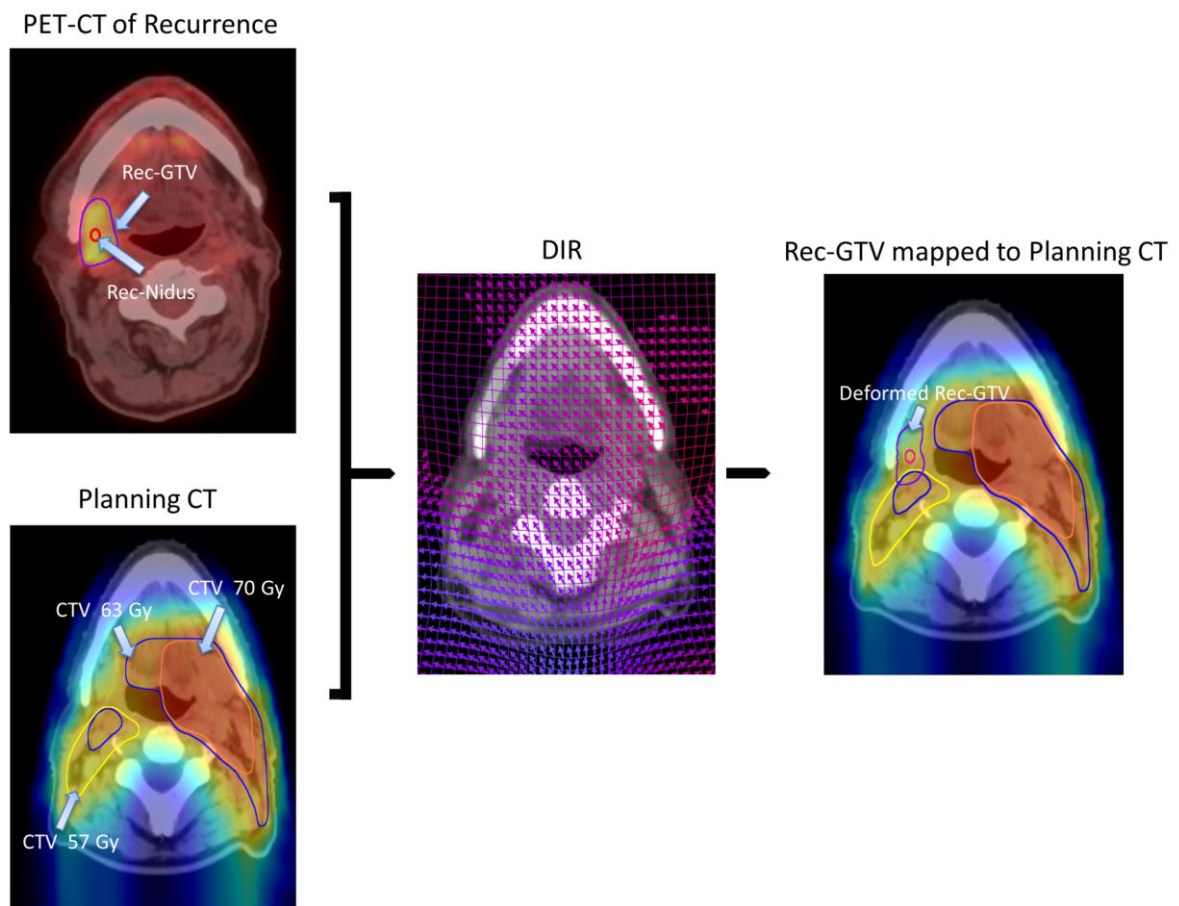


Supplementary Figure 1. Deformable image registration methodology for patterns of failure analysis: Contouring of recurrence GTV was done on patient's PET/CT documenting recurrence then deformable image registration (DIR) was applied to deform the PET/CT to the original planning CT. The deformation vector fields were then applied to rec-GTVs to convert it into 'deformed rec-GTVs' on the planning CT to calculate volumetric and dosimetric failure parameters.



Supplementary Figure 2: Failure analysis for those with locoregional failure and diagnostic imaging demonstrating the failure available for review.

A) Right level IIa nodal recurrence 12 months post-IMPT mapped to planning CT and dose where the centroid of the rec-GTV is located in GTV and minimum dose to rec-GTV was 72.6 Gy. B) Left level IIa nodal recurrence 20 months post-IMPT mapped to planning CT and dose where the centroid of the rec-GTV is located in CTV1 and minimum dose to rec-GTV was 66.4 Gy. C) Right (contralateral) glossopharyngeal sulcus recurrence 43 months post-IMPT mapped to planning CT and dose where the centroid of the rec-GTV is located outside target volumes and minimum dose to rec-GTV was 62.9 Gy.

