Purpose:
Images acquired daily during IGRT typically do not cover the entire treatment area, and they have lower image quality than the planning image. Conventionally, a small daily image is merged with the full-size planning image in order to form a complete picture of the patient in treatment position. In such a merged image, a given voxel contains new data if it was covered by the daily scan, and otherwise old data from the planning image. The aim of this work is to form a composite image from all available fractions so that the aggregate covers the entire target and exhibits higher image quality. Instead of using just the newest data at each voxel, all available data is blended together.

Methods:
Every image is segmented automatically into 5 tissue types and 42 anatomic structures. Warp fields that map daily images to the planning image are computed from 4-parameter rigid registration, 10-parameter Marionette deformation, and free-form deformation. The Marionette model allows small images to impact areas outside their scan because bone movements and weight loss are global. Each daily image is warped to every other daily image, and combined via weighted averaging. Weights are assigned to fractions based on age, deformation similarity, and STAPLE probabilities for mandible and spinal cord. Weights are assigned to voxels based on tissue discrepancy to secure data integrity and avoid blurring features.

Results:
The method was validated on head/neck datasets from 20 patients with a total of 466 daily images. The daily images are helical megavoltage CT. The SNR in muscle was measured to increase by an average of 55%, while CNR between muscle and fat increased by 50%.

Conclusions:
Image quality was measured to improve in all cases, and small daily images were shown to be useful components of a broader mosaic.