

Interfraction Duodenal Dose-Surface Map Changes with and without Abdominal Compression

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Purpose/Objective(s)

To quantify the effect of interfraction motion on duodenal dose-surface maps. It is hypothesized that due to this motion, there will be differences between the planned DSM (pDSM) and the accumulated DSM (aDSM), which can be reduced through abdominal compression. The MR Linac workflow includes high quality daily imaging with better soft tissue contrast than CBCT. Creating daily dose-surface maps for organs at risk could be useful for adaptive planning.

Materials/Methods

Eight patients treated with (n=5) and without (n=3) abdominal compression for locally advanced pancreatic cancer (BED > 50 Gy) were selected for analysis. CBCTs were rigidly registered to the planning CT (pCT) using a soft tissue match.

The duodenum was contoured by the same physician on the pCT and on each CBCT (5 CBCTs for compressed patients, 4 for non-compressed). Dose-surface maps were produced from each duodenum and scaled to 5 (compressed) or 4 (non-compressed) fractions to simulate hypofractionation by either dividing the pDSM or summing the individual aDSMs. The virtual unwrapping process involves identifying the superior (top) and the inferior (bottom) slice of the duodenum and splitting the organ into tubular segments before 'cutting' and unfolding each segment. This results in a pseudoregistration between duodena and therefore a straightforward summation was appropriate for creating aDSMs. Gamma analysis using a 3%/3mm criteria was used to compare these pDSMs to aDSMs. and surface map metrics representing the percentage of DSM pixels that receive at least 10% (SM10), 30%, 50%, 70%, and 90% of the maximum dose were also compared.

Results

The gamma passing rates between the pDSMs and aDSMs were 90%, 88%, 89%, 87%, and 88% for compressed patients and 77%, 84%, and 53% for the non-compressed patients. The mean (and range) differences in SM10, 30, 50, 70, and 90 for each compressed patient was 4% (0-11%), 3% (1-5%), 3% (0-9%), 7% (4-9%),

and 1% (0-2%) compared to 1% (0-4%), 5% (0-18%), and 18% (10-30%) for the non-compressed patients.

Conclusion

The results support the hypothesis that there are differences between the pDSM and aDSM, and also that abdominal compression can reduce these differences. Previous work has shown that abdominal compression reduces variation in volume and absolute position of the duodenum throughout treatment and this study shows that this can be seen in dose-surface maps. The reduced variation due to compression is seen as an improvement but does not eliminate the need to consider the interfraction dosimetric changes due to motion. Dosimetric changes to surface dose of up to 11% (compressed) and up to 30% (non-compressed) are observed, with an increase in surface area receiving high doses. CBCT image quality limited this study. Utilizing the high quality imaging and soft tissue contrast provided by an MR-Linac can overcome this limitation and accurate daily dose-surface maps can be produced. In the case of pancreatic cancer, the treatment plan could be adapted based on the daily dose to the duodenum.

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