

Purpose:

To report the characteristics of pancreas motion as tracked using implanted fiducials during radiotherapy treatments with CyberKnife.

Methods:

Twenty-nine patients with pancreas cancer treated in Stanford University and Georgetown University using CyberKnife system were retrospectively selected for this study. The CyberKnife uses a Synchrony[®] Respiratory Tracking system to obtain the position of the pancreas target. The system can monitor both the internal movement using implanted gold fiducial markers and the external movement using tracking markers. In pre-treatment patient positioning, the deviation of the target relative to the planning position is corrected by moving the treatment couch. During the treatment, the deviation is examined every 3-4 nodes (~45 s interval) and compensated by the robot. If there is significant deviation from the original step, the treatment is paused while the patient is repositioned by moving the couch. The pancreas displacement calculated from X-ray images acquired within the time interval between two consecutive couch motions constitute a data set.

Results:

A total of 498 data sets and 4302 time stamps of X-ray images were analyzed in this study. The average duration for each data set is 634 s. The location of the pancreas becomes more spreaded as the time elapses. The mean shift in each direction, averaged over all patients, was 5.38mm, 2.98mm, 3.27mm in the superior-inferior (SI), lateral (RL), and anterior-posterior (AP) dimensions, respectively. The average shift length is 7.06mm.

Conclusions:

The pancreas target moves significantly and unpredictably during treatment. The intra-fractional movement of pancreas is 2~3 times larger than prostate. Effective means of compensating the intra-fractional movement is critical to ensure adequate dose coverage of the tumor target.