Program No.

Interfraction variability of patient's breathing undergoing lung SBRT treatment

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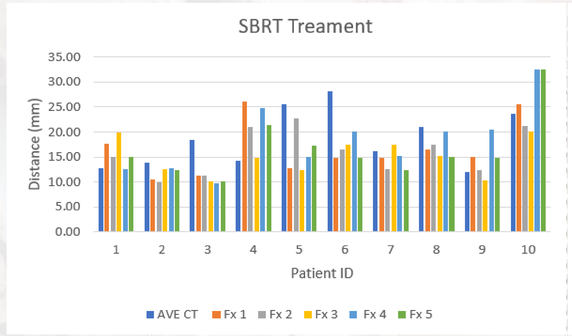
Introduction
Stereotactic body radiation therapy (SBRT) developed in 2002 and studies regarding the recent technology begun to reveal the level of precision and accuracy the SBRT system is in comparison to other modalities. The SBRT algorithm can create plans for complicated target locations surrounded by organs at risks (OARs) with far less risk for patients, increases patient survivability. SBRT dose fall-off rate is precise to the millimeter to keep the high Isodose line (ISL) in the dose gradient off OARs near the target such as keeping the high ISL off the heart while treating the lung.
Another part of the radiation treatment is the reduce patient motion during treatment. For Lung cancer patients, breathing techniques are used to provide appropriate coverage of the target. With SBRT, there are a variety of techniques used; free breathing (FB), breath hold (BH), and abdominal compression (AC). Free breathing is the least controlled technique where the patient may breathe too fast or too deep or too shallow. Changes in breathing amplitude may lead to the reduction of the overall dose to the target. If erratic breathing occurs, abdominal compression or breath hold may be used as a preventative.

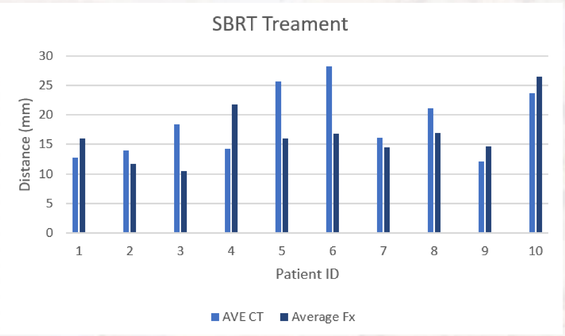
Aim:
The aim of this study is to investigate the consistency of free breathing planning margins for fractionated SBRT treatment in the lung. To determine this, the breathing motion from the average CT (AVE CT) scan, will be compared to the CBCT from each treatment session.

Literature Review:
In a previous study, multiple treatment sites on different organs were used to determine if the patient breathing motion caused a significant impact on kidney treatment site. The author measured the kidney to identify if there was significant change in location from where the planned site originally was. The authors tested multiple breathing techniques (FB, BH & AC) to ensure all techniques were reviewed.

Methodology:
Patients are selected by lung cancer, SBRT treatment, and breathing technique used. The patient's diaphragm will be measured using the profile tool in contour. The AVE CT & CBCT for each fraction received will be compared on the graph quantitatively. A Table will be created to show data for clarity from at least 10 patients that measure the diaphragm change for every patient. The shaded HU distortion between the diaphragm and the lung will be measured to conclude how much movement occurs during treatment. If the difference is significantly greater than 0, chances for Interfraction variability during treatment may be significant enough to greatly impact proper treatment of patient.

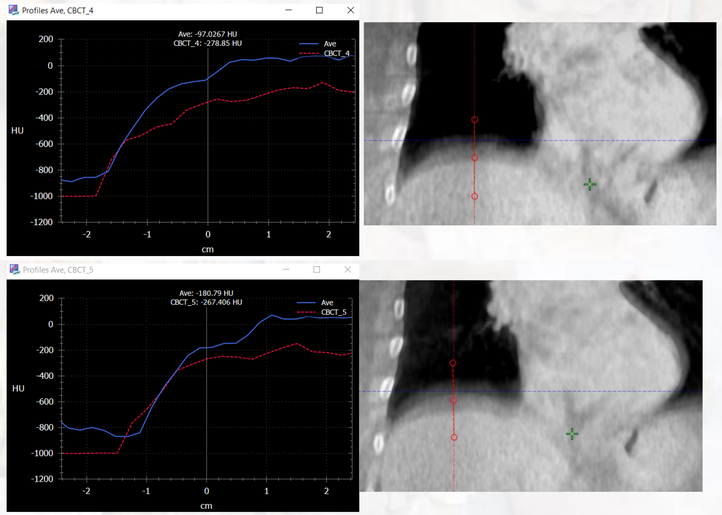
Data:

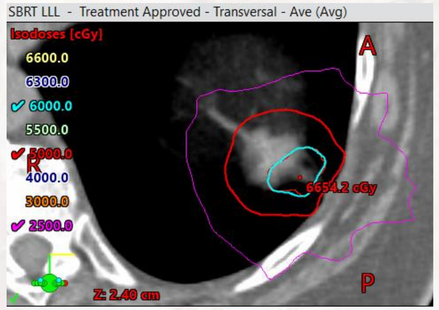




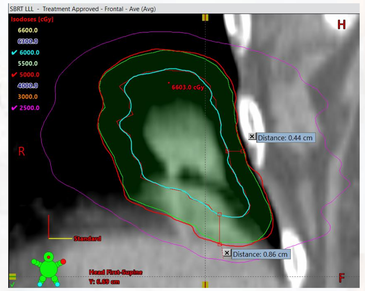
Results:
10 plans made with the AVE CT compared to CBCT for each patient showed an average of 17% decrease in distance of the diaphragm compared to the AVE CT scan made. For each individual plan, the average of increase in diaphragm distance for the 10 patients was 4:6. One outlier showed the diaphragm increased by 1.75 times the AVE CT.

Below: Images from Patient #9 fractions 4 & 5





Above and Below: Patient 9 (LLL)
ITV: Small red circle (Adjacent to Teal)
PTV: Green area
5000 cGy (Goal) for PTV: Big red circle
6000 cGy (Goal) for ITV: Teal circle



Conclusions:
The results of these patients undergoing SBRT treatment showed on average more patients are over treated by 60% where as some patients are undertreated. There were a few outliers where on one day the patient was breathing deep compared to other days they were treated that significantly changed the average of their diaphragm distance during CBCT. The results indicate the side-effects of breathing rhythms while undergoing SBRT for lung treatment. A deep or shallow breathing can significantly impact the treatment of the patient. The closer the target is to the diaphragm, the more pertinent the proper repetition of breathing becomes.

Outside Breathing exercises to help calm the patients:
Yoga, Tai-chi, massage, meditation

Breathing exercises prior to treatment:
Focus breathing, belly breathing, 4-7-8 breathing, box breathing

Questions:
What's the impact of a larger margin?
How accurate is the measuring?
What's the impact if the target was further away from the diaphragm?

References:
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