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Evaluation of Intra-and Inter-fraction Motion in Breast Radiotherapy Using Electronic Portal Imaging Cine Loops

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INTRODUCTION

Parallel tangent breast irradiation is commonly used post breast conservation surgery for early breast cancer patient without lymph node involvement to improve local disease control. Intra-fractional and inter-fractional variabilities are often presented in daily treatment setup. The present pilot study used Electronic Portal Imaging (EPI) to evaluate intra- and inter-fraction motion in patients undergoing simple breast tangent radiotherapy.

METHOD AND MATERIAL

1. *Study Population*:

Female with breast cancer (Tcis, T_{1-2}, N_0) post breast conservative surgery, requiring simple breast irradiation and able to sign consent. The total irradiation dose varied from 45-5000 cGy in 25 fraction treated with photons megavoltage energy 10MV and dynamic wedges on a 21G Varian Linac . A breast board (Med-Tec) was used for patient positioning.

2. *Study Procedure*:

A liquid ionization chamber based EPI of a Varian Linac was utilized for image acquisition. Images were acquired in the medial/lateral field. As the images were acquired using the treatment beam no additional dose was given to the patients. Depending on the incident dose and the angle of the dynamic wedge used between 4 and 10 images could be acquired in one session.

For patients participating in the study, images were taken on multiple treatment days (min 4, average 8±2 images were taken per fraction).

Digital portal images were taken in any eight fractions of the treatment scheme for each participant. Three measurements were made from each image. They are: **A) Central Flash Distance (CFD); B) The Inferior Central Margin (along the axis) (ICM); and C) the Central Lung Distance (CLD).(**Figure 1) .

3. *Data Analysis*:

Table 1 is a sample of data collection of a measurement in a single fraction. The mean of a measurement's standard deviations of all available fractions from a patient was the average intra-fractional variability of a particular measurement for the patient. The standard deviation of a measurement's means of all fractions for the patient represented the inter-fractional variability of this measurement for the patient.

RESULTS

Five patients were piloted. The measurements increased the treatment time by less than ONE minute. The border between Lung and chest-wall could easily be detected in all images. Table 2 shows the results of 5 patient measurements. The max range is the difference of the minimum and maximum of that particular measurement throughout all the available fractions. Inter- and intra-fractional variabilities are the averages from each patient obtained with the methodology explained previously. Figure 2 shows the intra- and inter-fraction variation for one patient (distances during the first fraction and mean distances in 8 fractions).

Table 3 summarizes the overall averages (combining the data from all 5 patients) observed in the pilot study.

Among all the measurements taken, inter-fractional variabilities were always larger than intra-fractional variabilities as illustrated for one patient in figure 2. The differences between inter-fractional and intra-fractional variabilities were not consistent throughout. Both CFD and CLD were relatively stable for the 5 patients involved in the study.Compared to CFD and CLD.ICM displayed greater variations. It was 1.8+/- 1.1mm intra-fractionally and 3.6+/- 1.9mm inter-fractionally, which was approximately 1.5-2 times greater than CFD and CLD.

DISCUSSION

Acquisition of EPI cine loops in our pilot study proved to be a feasible quick and easy technique to establish the amount of patient involvement during breast radiotherapy. Despite the somewhat limited image quality (compare figure 3) it was always easy to identify the tissue/air and tissue/lung interfaces of interest. As the images were acquired during normal treatment no additional dose was given and breast radiotherapy appears to be a good site to perform frequent EPIs for patient positioning.

Further investigation is underway to confirm the results of the pilot study and to explore the feasibility of clinical trial for conformal dose delivery (using compensators or IMRT).

TABLE 1

Image #	CFD	ICM	CLD
1			
2			
3			
4			
5			
6			
7			
8			
Min			
Max			
Range			
Sum			
Total Images			
Mean			
S.D.			

TABLE 2

CFD					
Subject	1	2	3	4	5
Max range	0.86	0.86	0.95	1.35	2.1
Interfx variability	0.15	0.24	0.24	0.40	0.4
Intrafx variability	0.085	0.12	0.085	0.083	0.083
ICM					
Subject	1	2	3	4	5
Max range	2.16	2.46	0.95	3.61	3.15
Interfx variability	0.38	0.46	0.24	0.61	1.60
Intrafx variability	0.23	0.33	0.085	0.21	0.021
CLD					
Subject	1	2	3	4	5
Max range	0.73	0.84	0.95	1.1	0.65
Interfx variability	0.16	0.24	0.15	0.29	0.29
Intrafx variability	0.070	0.11	0.11	0.096	0.029

TABLE 3

	Intrafractional	Interfractional
CFD	0.9 +/- 0.1	2.9 +/- 1
ICM	1.8 +/- 1.1	3.6 +/- 1.9
CLD	0.9 +/- 0.2	1.8 +/- 0.9

FIGURE 1

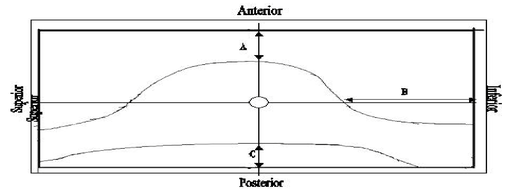
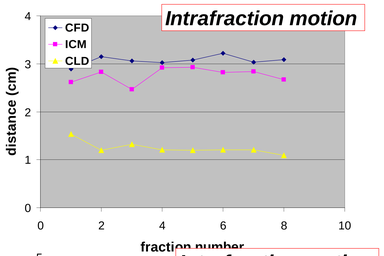


FIGURE 2



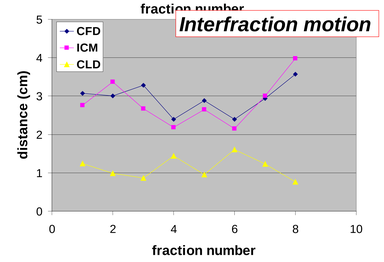


FIGURE 3