# Implementation of a breath-hold lung gating system for left-sided breast cancer; hurdles and benefits

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## Purpose/Objective

Left sided breast cancer poses a significant challenge in sparing the heart and specifically the left descending anterior coronary vessels (ACV). Lung Gating is seen as a useful method to maximize both PTV coverage and OAR sparing but is also associated with increased complexity, cost and time. We prospectively evaluated the cost-benefit of a modern system implemented in a busy community hospital environment.

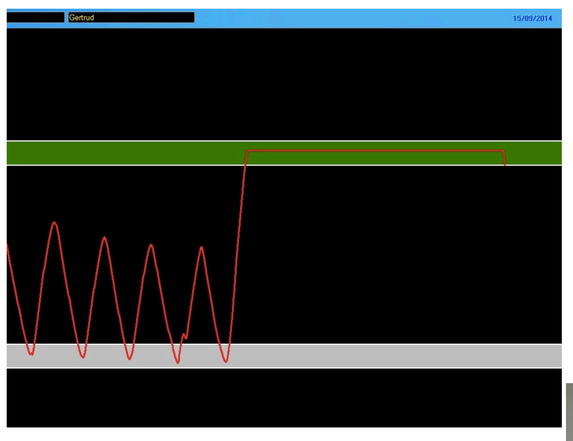


**Figure 1**: *Screenshot of breathing-curve; regular breathing on left, inspiration breath-hold in green "target-zone" on right*

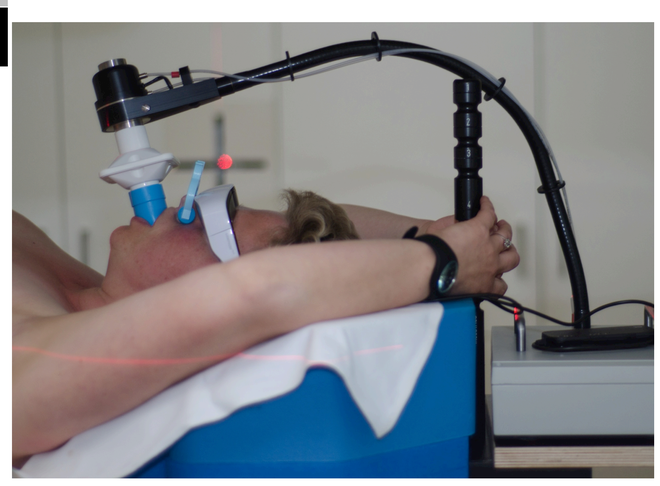


**Figure 2**: *Lung-Gating setup: The patient is able to see her breathing-curve (Figure1) on her video goggles.*

## Materials and Methods

A lung gating system based on the breath-hold technique (SDX, QFix, Avondale PN, USA) ***(Figures 1&2)*** was evaluated on our 26 initial consecutive patients with left sided breast cancer. Breath hold training and the acquisition of an inspiratory (IN) and expiratory (EX) planning dataset were the basis for deciding which patients would be eligible for gated irradiation. After contouring of PTV, left lung, heart and LCV in the IN dataset, the structures were copied to the EX dataset and adapted non-rigidly. Treatment planning was performed in identical manner for both datasets (IMRT via mainly 2 tangential fields with up to 16 segments ***(Figures 3&4)*** .

ACV and heart dose was analyzed using Wilcoxon rank-sum test.

Weekly tangential portals were analyzed for repositioning accuracy in A-P direction.

Statistical significance was defined as $p<0.01$.

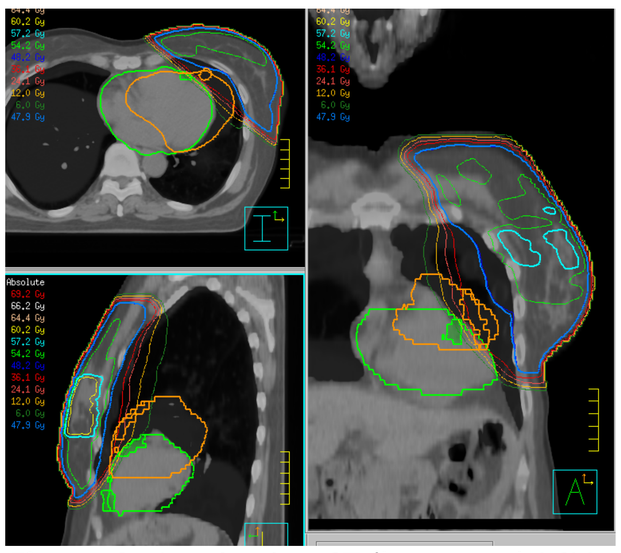
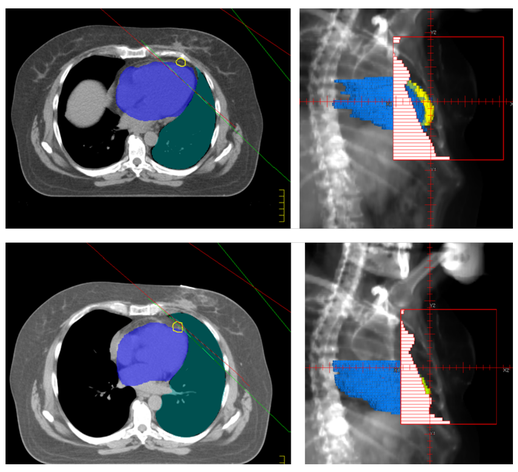


**Figure 4**: *Inspiration CT (heart and ACV green contours, expiration position of these structures superimposed in orange) and simultaneous integrated boost treatment isodose lines.*
*Typical sparing of the heart and LCV in IN*

**Figure 3**: *Expiration (top) and Inspiration (bottom) CT: heart(blue) and and ACV (yellow) contours. The beam projections in the axial slices and DRR clearly show the heart and ACV sparing in the IN dataset.*



## Results

Of the initial 26 consecutive patients (one was blind), 25 could be CT-planned with the system resulting in 2 datasets each (IN and EX). Of these, 14 (56%) were initially selected for treatment in inspiration due to a significant difference in one or more OAR. Lung gating had to be discontinued in two patients after 3 and 2 fractions respectively due to breath-hold difficulties which had not been apparent during the training session. In patients initially selected for lung gating, the maximum (D02) and median (D50) doses to the ACV were 12.8 (range 2.9-48.3) Gy and 3.6(1.8-25.1) Gy, respectively and were significantly lower than those derived from the EX plans ($p=0.0001$) . The corresponding doses in the EX plans of patients not selected for lung gating were 35.7(7.2-57.2) Gy and 7.3(3.1-39.7) Gy for D02 and D50, respectively, which was not significantly different from their IN plan values ***(Fig. 5A)***.

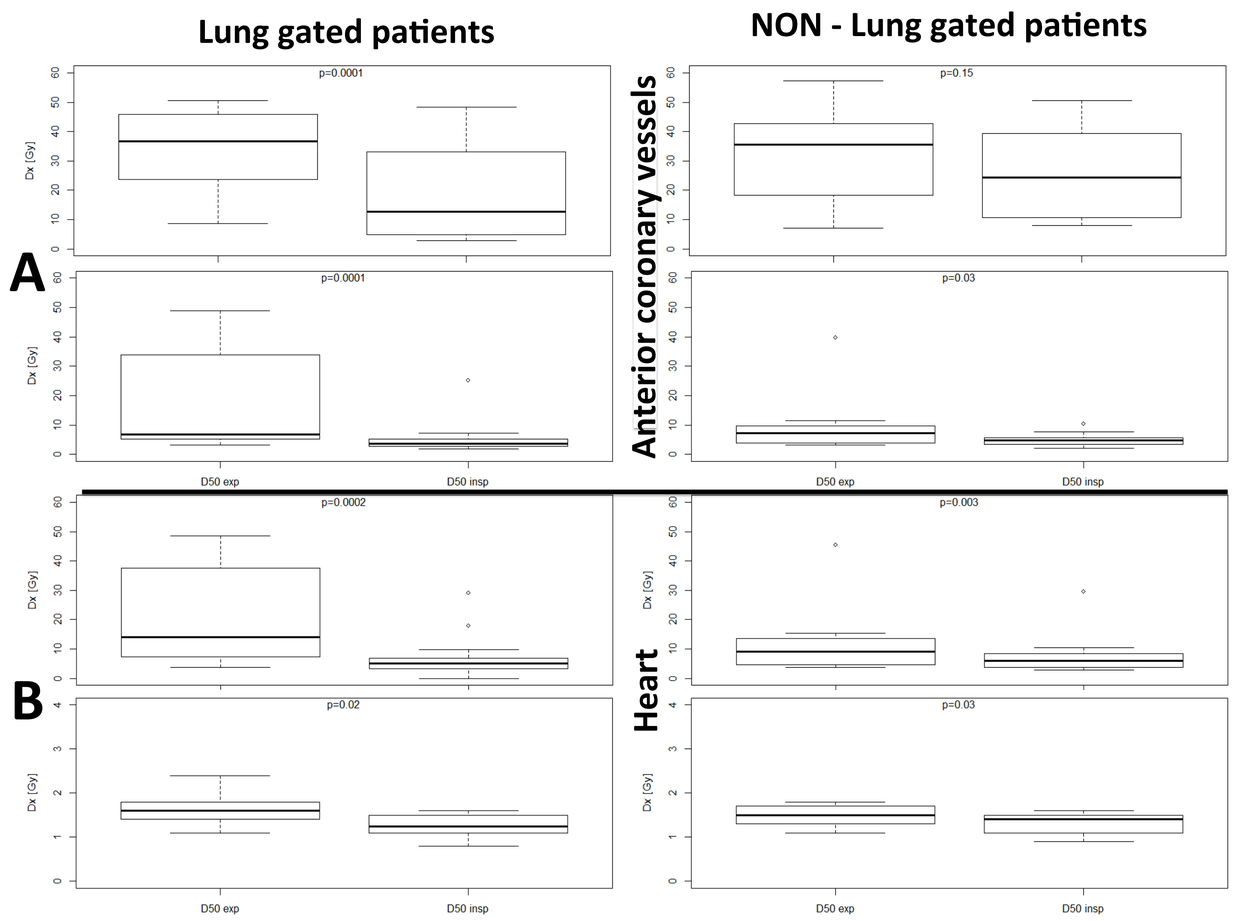
Significant heart-sparing was achieved in both groups, albeit more pronounced in the patients selected for lung gating ***(Fig. 5B)***.

Better ACV and heart sparing in lung gated patients was not due to compromising PTV coverage: The volume of the PTV covered with 95% of prescribed dose was 89(73-97)% and 89(83-97)% for lung gated and non-lung gated patients, respectively ($p=0.60$).

Median treatment times were 478±63s seconds for the lung-gated patients vs. 278±37s seconds for the patients treated without.

The average A-P deviation of the AP Portals (n=81) from the lung gated group was 2.1 mm.

**Figure 5**: *Scatterplots comparing D50 and D02 of ACV(**A**) and heart(**B**) between lung-gated and non-lung gated patients*




## Conclusion

Based on the very first patients treated at our department, we were somewhat surprised that lung gating prolonged treatment time only by 3-4 minutes per fraction and offered significant benefits on OAR sparing to about half the patients. Thorax excursion reproducibility is highly accurate with this system.

As a limitation, it is only suitable for patients who are fully compliant.