

Treatment of a right upper lobe lung tumor using Active Breathing Coordinator™ in a patient with severe pulmonary insufficiency

Institution:	Centre Régional, Léon-Bérard, Lyon, France
Patient:	68-year-old male
Motion management:	Active Breathing Coordinator™
Diagnosis:	Right upper lobe lung tumor
Plan:	3D conformal 12 beam 6MV photons
Treatment:	70Gy in 35 fractions



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Patient history

A 68-year-old male, former smoker, presented with a long history of severe pulmonary insufficiency, which had been managed for several years with oxygen therapy. More recently, as his pulmonary function improved the oxygen therapy was stopped.

A recent radiograph showed a 4cm diameter tumor in the right upper lobe. CT-scan confirmed a solid mass 48 x 42mm in right upper lobe, with suspicious infra-cranial nodes (between 15 and 20mm in diameter). A PET scan showed a fixed primary tumor but a mobile mediastinum. Cranial CT and abdominal CT were normal. The tumor was considered as stage T2-3 N0-M0.

Planned treatment

Due to the patient's pulmonary insufficiency, an explorative thoracotomy was performed rather than radical surgery. The patient was then proposed for radiation therapy and a course of radiation therapy was prescribed. This patient was included in a French clinical study evaluating the breath hold advantage with respect to acute radiation pneumonitis. A conformal treatment plan was created using the CMS® (an Elekta company) treatment planning system, consisting of twelve 6MV photon beams. The total dose prescribed at the center of the PTV was 70Gy, delivered in 2Gy per fraction (according ICRU recommendations). The dose calculation was made using the superposition algorithm (with inhomogeneity correction) (CMS Xio). (see figures 1 and 2) (see patient table below).

Prescribed dose : 70Gy – 12 beams – breath hold level : 1.2L – breath hold duration : 17s

Modality	GTV volume (cc)	PTV volume (cc)	Mean lung density (HU)	Right lung height (cm)	Left lung height (cm)	Right lung volume (cc)	Left lung volume (cc)	Lung-PTV DVH		
								V20 (%)	V30 (%)	Mean dose (Gy)
Free breathing	121	598 (1)	-783	15.2	15.9	1853	1729	43.7	25.2	18.2
Breath hold	110	427 (2)	-851	18.4	17.5	2503	2403	28.9	18.5	15.9

(1) margins used : GTV => CTV : 5mm ; CTV => ITV : 5mm (AP, RL) and 10 (SI) ; ITV => PTV : 5mm

(2) margins used : GTV => CTV : 5mm ; CTV => ITV : 3mm (residual movement) ; ITV => PTV : 5mm



Figure 1: dose distribution on coronal view – breath hold treatment planning

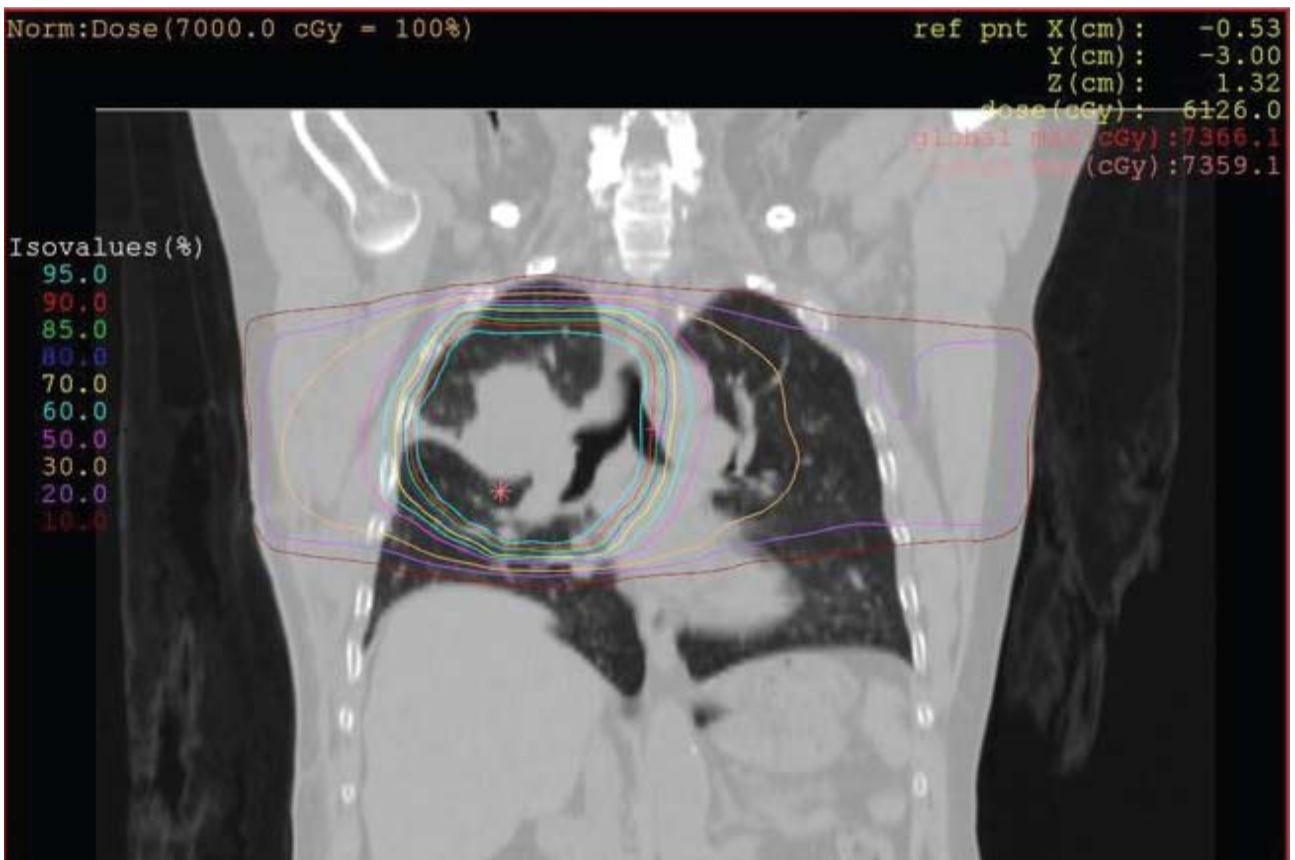


Figure 2: dose distribution on coronal view – free breathing treatment planning



Figure 3: patient set-up (alpha cradle, mould, mouth piece and mirror)

Treatment using Active Breathing Coordinator™

The patient was positioned in an alpha cradle mold with arms raised above the head (see figure 3). Two training sessions, of 15 minutes each, were required to set an appropriate breath hold duration and volume and also to ensure the patient was comfortable with the Active Breathing Coordinator technique. The first session simply helped to determine the predefined breath hold levels which, for this patient, were set at about 0.2L above tidal volume with a breath hold duration of 17s. (see figure 4).

A second training session took place immediately before the CT acquisition, to ensure the patient was still comfortable with the predefined levels for the breath hold.

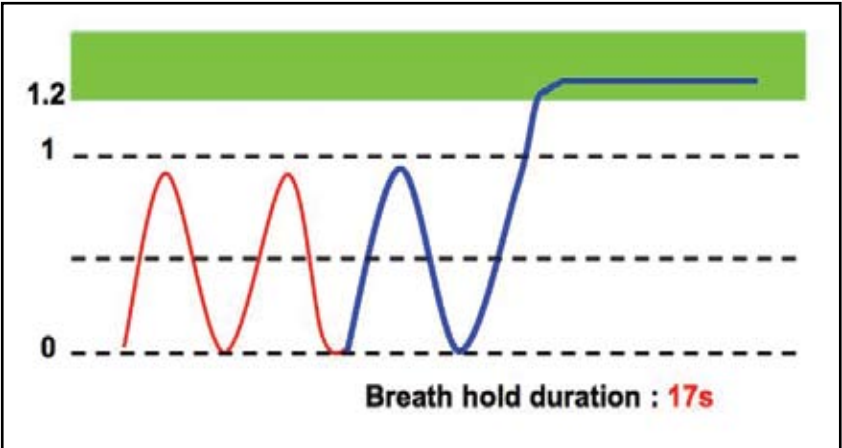


Figure 4: patient breathing curve

One CT scan was acquired under breath hold. Our new CT scanner (Philips Brilliance CT Big Bore) is capable of acquiring an image of the whole lung with only one breath hold. A second CT scan was acquired under free breathing.

Before each treatment session, the radiation therapists verify that the tidal volume and the breath hold levels set during the training session are still achievable. Each treatment beam is delivered during a single breath hold. Additional time required at each treatment session is less than five minutes.

Active Breathing Coordinator™ advantages for patients with pulmonary insufficiency

The major achievements of treatment with deep inspiration breath hold with Active Breathing Coordinator is

- to decrease target margins and fieldsize by immobilization of the tumor (cf. PTV volume and DRR) (see figures 5, 6, 7 and 8)
- to spare normal lung tissue from high doses by expanding the lung (lung volume and DVH).

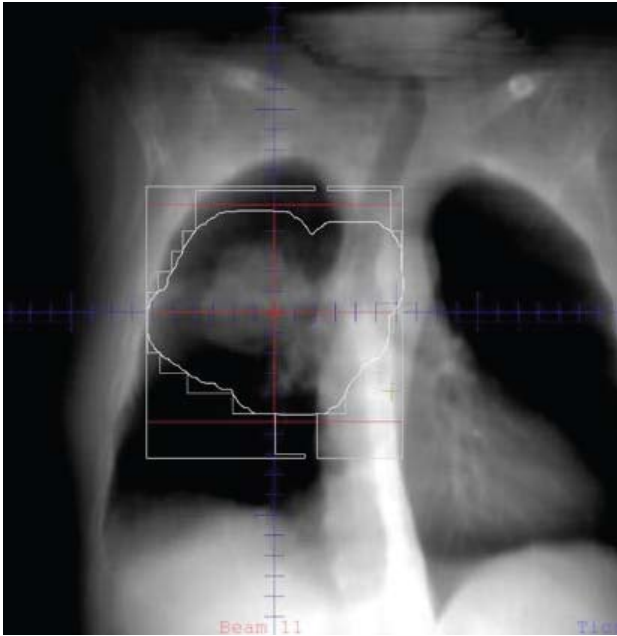


Figure 5: anterior DRR breath hold

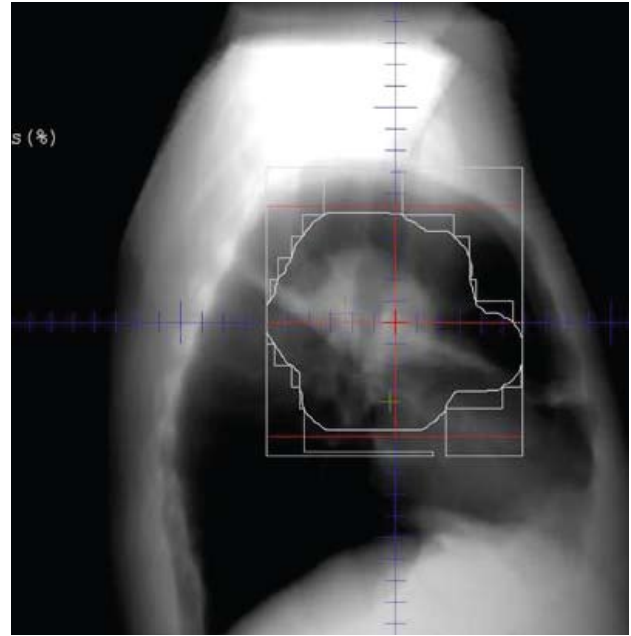


Figure 6: Lateral DRR breath hold

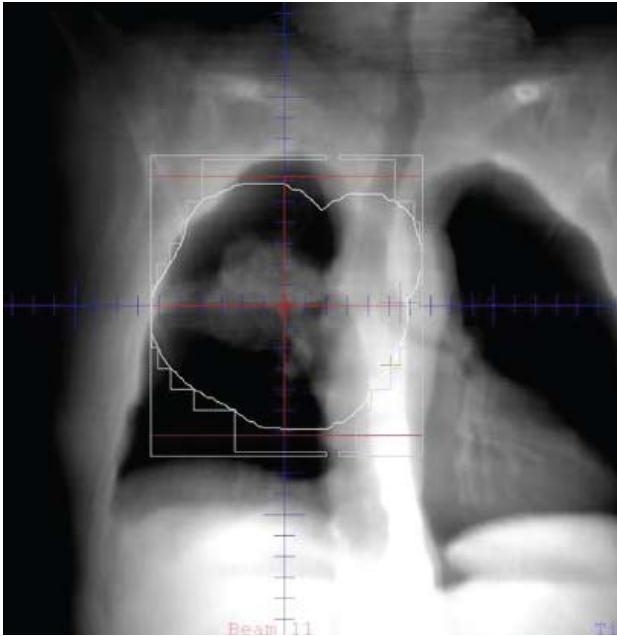


Figure 7: anterior DRR free breathing

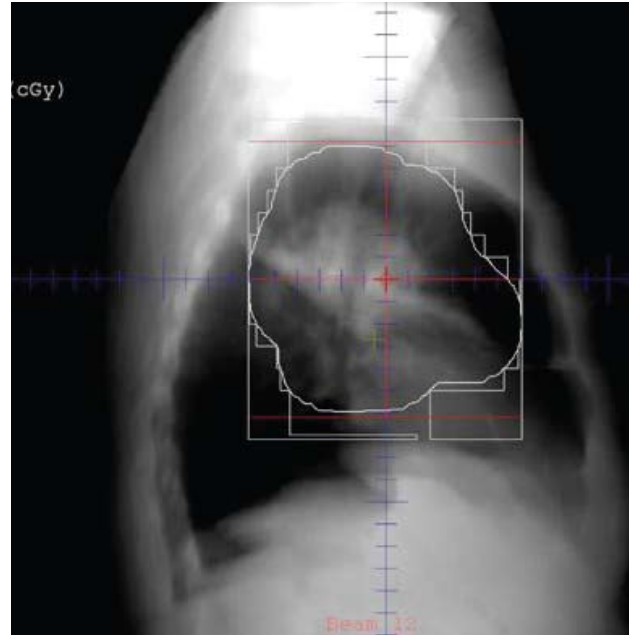


Figure 8: lateral DRR free breathing

A comparison of the lung DVH between the breath hold and free breathing plans shows that the breath hold treatment ensures that lung doses remain within tolerance levels ($V_{20} < 30\%$ and $V_{30} < 20\%$) contrary to free breathing treatment. The breath hold treatment with Active Breathing Coordinator is also feasible for those patients with respiratory insufficiency.

References

- *Active Breathing Control for Hodgkin's Disease in Childhood and Adolescence: Feasibility, Advantages, and Limits*, 8 January 2007 Line Claude, Claude Malet, Pascal Pommier, Philippe Thiesse, Sylvie Chabaud, Christian Carrie *International Journal of Radiation Oncology * Biology * Physics* 1 April 2007 (Vol. 67, Issue 5, pages 1470-1475).
- *Nonrigid registration method to assess reproducibility of breath-holding with ABC in lung cancer*, David Sarrut, Vlad Boldea, Myriam Ayadi, Jean-Noël Badel, Chantal Ginestet, Sébastien Clippe, Christian Carrie *International Journal of Radiation Oncology * Biology * Physics*, 1 February 2005 (Vol. 61, Issue 2, pages 594-607).

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