

An improved active breathing control (ABC) apparatus to immobilize breathing motion.

Organ motion associated with breathing is problematic for dose escalation. The approach of active breathing control (ABC) can be used to temporarily immobilize breathing motion by sealing off airflow with a computer-controlled valve. ABC can be applied repeatedly at any pre-determined phase of the breathing cycle. The concept was tested successfully with a modified servo-ventilator. Organ position was immobilized reproducibly to within ± 3 mm. As the ventilator was unsuitable for practical use, a prototype single valve ABC apparatus was constructed. Initial patient studies showed that treatment under ABC allowed significant reduction of treatment margin as compared with free-breathing treatment. However, several areas of improvement were identified. (1) The analog flow meter responded non-linearly to flow, resulting in undesirable variation in lung volume determination. Reproducibility of organ immobilization was thus dependent on patient's performance. (2) The system exhibited temperature dependent signal drift that required reset during operation. (3) The use of a pediatric valve increased flow resistance that was annoying to some patients. In a new ABC apparatus, a digital flow transducer effectively solves the first two problems. A large bore balloon valve greatly reduces flow resistance. Laboratory studies show that volume measurements were reproducible to within 4% at normal breathing flow rates. The improved performance would improve reproducibility of breathing motion immobilization. *This work is supported in part by NCI grant RO1-CA76182 and Elekta Oncology Systems, Inc.*