Purpose: To challenge the notion that the radiation beam must be held on as the gantry rotates around the patient and to describe a new approach for delivering intensity modulated arc therapy, beam-controlled arc therapy (BCAT), during which the radiation beam is controlled on or off and the dose rate is modulated.

Methods: Conventional IMAT presupposes that it is beneficial to delivery radiation from all beam angles as the gantry rotates, requiring the MLC to maintain continuity in shape from one angle to another. In turn, radiation from undesirable beam angles compromises the dose distribution. We propose a new approach to IMAT, BCAT, in which the radiation beam is held on or off and the dose rate is modulated while the gantry rotates around the patient. We employ linear-programming-based dose optimization to each aperture weight, resulting in some zero weight apertures. During delivery, the radiation beam is held off at control points with zero weights as the MLC shape transits to the next non-zero weight shape. This was tested on 10 head and neck cases. Plan quality and delivery efficiency were compared with conventional IMAT.

Results: Improvements in OAR sparing and target dose uniformity at dose/volume constraint levels were up to 18% (p-value 0.002) and 67% (p-value 0.04) respectively. Comparing to 180 and 360 apertures used in single-arc and double-arc IMAT plans, BCAT used 98 and 170 apertures on average respectively. The difference of total MUs used for IMAT and BCAT plans was less than 4%. Although BCAT resulted in a significant number of control points having zero MUs associated with them, the delivery times were comparable.

Conclusions: Our results demonstrate that the BCAT approach, which allows the radiation beam to be controlled on and off, yields superior dosimetric results relative to the conventional IMAT while maintaining the delivery efficiency.

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