Austin, TX
July 21, 2014

Debate Motion

"Arc Based Techniques Will Make Conventional IMRT Obsolete"

AGAINST the Motion:

Peter Balter, Ph.D.

Potential Conflicts of Interest:
Dr. Balter has research support/collaborations with
- Varian Associates
- Philips Medical Systems
- Sun Nuclear Corporation

All of whom have products show in this presentation

Theoretical benefits of VMAT:

- Faster treatment delivery

Real Costs of VMAT

- Linac upgrade
- TPS Upgrade
- R&V Upgrade
- IMRT QA system upgrade
- Increased linac downtime
- Longer planning time
- Greater physics QA time

Linac Upgrade

- Costs to upgrade an existing linac
  - *$150,000-$250,000*
  - *What do you get for your quarter million ?*
    - Flag is changed from no to yes is the software
    - If you have an older gantry chain it is replaced
  - *Extra if you want gating with your upgrade*
- If not all linacs in a center are upgraded
  - *Lose the ability to transfer some patients*
  - *Lose conformal arc on the other machines (for safety reasons)*

TPS Upgrade

- Requires new licenses to optimize VMAT
- Requires upgrade computational hardware (if you wish to optimize in less than half a day)

R&V Upgrade

- Requires an installer to come to your site and change a flag from no to yes for each linac upgraded
- Requires an increased annual license fee for this extra service

IMRT QA system upgrade

- May of us moved from Film/Ion chamber to planner arrays
- VMAT QA with planner arrays can be non-optimal and require
  - *Extra phantoms*
  - *Gantry mounts*
  - *Specialized IMRT QA devices*

Increased Linac downtime

- MLCs, gantry and dose must all be coordinated
- MLC components that were able to perform for step and shoot treatments cannot always meet the velocity requirements needed for VMAT
  - *Motors*
  - *T-nuts*
- MLC maintenance must be increased
  - *Disassembly and cleaning has become frequent since we started VMAT*

Longer planning time

- TPS systems that could optimize a 5-8 field IMRT plan in 10-20 minutes may take several hours to optimize a 2 arc VMAT
  - *Forces compromise on dose grid*
  - *Forces acceptance of plans that are "good enough" rather than optimal*
  - *Requires detailed study of collisions for non-centered targets*

Greater Physics QA time

- New QA methods need to be implemented to test the ability of the linac to coordinate MLC, collimator, and gantry motions with doserate
  - *If you are lucky the manufacture helps*
- New software needs to be written or purchased to analyze the results
- Additional tests need to be done each month (maybe each day)

J. L. Bedford and A. P. Warrington, "Commissioning of volumetric modulated arc therapy (VMAT)," Int. J. Radiat. Oncol., Biol., Phys. **73**(2), 537–545 (2009).

C. C. Ling *et al.*, "Commissioning and quality assurance of RapidArc radiotherapy delivery system," Int. J. Radiat. Oncol., Biol., Phys. **72**(2), 575–581 (2008).

Theoretical benefits of VMAT:

- Slightly faster treatment delivery
  - *Delivery time has been show to be decrease by 50-80% with VMAT: This corresponds to 2-4 minutes*
  - *This benefit decreases as the number of arcs increase (we have found we often need 3 or 4 arcs to obtain the same plan quality as fixed field IMRT).*
  - *Total room cycle time*
    - Patient transport and changing
    - Setup and imaging
    - Patient availability
  - *Auto field sequencing removes much of the time benefit of VMAT since a set of fields can be moded up together*

D. Wolff *et al.*, "Volumetric modulated arc therapy (VMAT) vs. serial tomotherapy, step-and-shoot IMRT and 3D-conformal RT for treatment of prostate cancer," Radiother. Oncol. **93**(2), 226–233 (2009).

VMAT plans have been shown to be are non-inferior

- Studies have show that VMAT plans can be made "as good" as fixed field IMRT
  - *In dosimetry studies the 2nd run plan is always better*
  - *To achieve comparable results we have had to go up to 3 or 4 arcs eliminating the time savings in delivery and costing more calculation time.*
  - *The extra time requires for VMAT optimization can lead to Dosimetrists accepting plans that are "good-enough"*

VMAT can be inferior to fixed field IMRT

- Fixed field IMRT has more degrees of freedom than VMAT
  - *VMAT*
    - MLC leaf speed limitations
    - Gantry speed limitations
    - Dose rate limitations
    - Couch angle and position limitations (including a higher penalty on multiple isocenters)

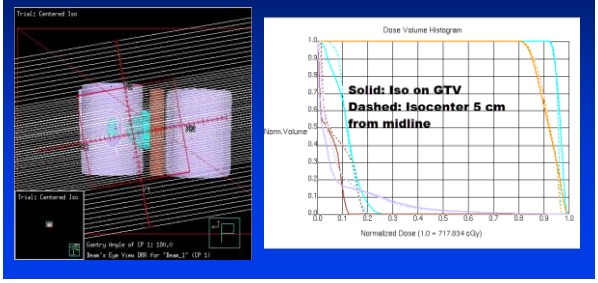
M. T. Studenski *et al.*, "Clinical experience transitioning from IMRT to VMAT for head and neck cancer," Med. Dosim. **38**(2), 171–175 (2013).

B. Fahimian *et al.*, "Trajectory modulated prone breast irradiation: A LINAC-based technique combining intensity modulated delivery and motion of the couch." Radiother. Oncol. **109**(3), 475–481 (2013).

VMAT may encourage/require moving isocenters away from the target

- Our linac QA is "isocentric"
  - *Gantry and collimator angles would need to be accurate to a much tighter level than current recommendations*
  - *kVp/CBCT/MV image systems would need to be checked at various positions away from isocenter*
- Non-isocentric treatment result in the MLCs having to move across the field during treatment increase the amount of interleaf leakage to normal structures

VMAT may encourage/require moving isocenters away from the target



Summary (1 of 2)

- ARC therapy has many costs
  - *Money*
  - *Time*
  - *Maximum Achievable Plan Quality*
- ARC therapy has 1 benefit
  - *Time*

Summary (2 of 2)

- For many patients ARC therapy will result in reasonably quality and quickly deliverable treatments
- For most patients the plans and delivery time will be comparable with fixed field IMRT
  - *Especially with auto-field sequencing*
- For some patients fixed field IMRT will be superior
  - *Tumor locations that are far from the patient's mid-line*
  - *Tumors/normal tissues that benefit from non-co-planer beams*

~~"Arc Based Techniques Will Make Conventional IMRT Obsolete"~~

- ARC Based Techniques may supplement/replace fixed field IMRT for many cases but not all and not any for some institutions with limited resources
- Thus the motion is not supported

Thank You

Fixed field IMRT

VMAT

Each technology has its place