Response assessment using the ViewRay MRIdian Linac

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Affiliations/ Disclosures / Conflicts

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Learning Objectives

1. Understand the concepts of MRI-guided radiation therapy that enable tumor response assessment during RT.

2. Understand the magnitude and frequency of occurrence of tumor volume changes during RT.

3. Understand the clinical advantages and limitations of target volume changes during MRI-guided radiotherapy.
Improved Soft Tissue Image Quality

Improved Soft Tissue Image Quality

Improved Target Volume Delineation

Renal Cell Carcinoma
SBRT Lower Pole Left Kidney

10 Gy per fraction to a total of 50 Gy

Eovist MRI shows
Metastasis the Best

Non-Contrast CT     Iodine Contrast CT     Eovist Contrast MRI

Image Quality for setup at other
disease sites

Breast
Pelvis (Bladder, GYN, Rectal, Prostate)
Kidney
Conclusion

• Serial MRI in 60 patients with advanced cervical cancer at the start of RT, during early RT (20–25 Gy), mid-RT (45–50 Gy), and at follow-up (1–2 months post-RT).

• The best method and time point of tumor size measurement to predict outcome was tumor regression rate in the mid-therapy MRI (at 45–50 Gy) using 3D ROI volumetry over simplistic diameter measurement with film.

• Mid-therapy MRI are needed to quantify tumor regression rate for prediction of treatment outcome.
Bladder ca - 3 Gy/fx - 10 of 20

Oligometastatic Liver ca – Simulation

Oligometastatic Liver ca – 10 Gy/fx - 5 of 5
Lung Carcinoma
SBRT 10 Gy/fix

Simulation Prior to Fx 5

Response Assessment

GTV at the Start of Treatment and at Fraction 10 on Axial TRUF MRI

Response Assessment

Fig 3. Mean and SD of ΔGTV\textsubscript{V} at Various Time-Points During Treatment in Responders and Non-Responders

Courtesy Dr. Bindu Musunuru/hmusunuru@wisc.edu
Response Assessment

Fig 2. Mean and SD of \( \Delta \text{GTV} \) at Various Time-Points During Treatment in All Patients

GTV at Fx 20

GTV at Fx 15

GTV at Simulation

Fig 3. Mean \( \Delta \text{GTV} \) (%) between Baseline and Every 5th Fraction

Fractions*23 for GEJ and 25 for Rectum

Courtesy Dr. Bindu Musunuru (hmusunuru@wisc.edu)
Early temporal changes during RT in heterogeneous regions of high and low perfusion in gliomas might predict for different physiologic responses to RT. This might also open the opportunity to identify tumor sub-volumes that are radioresistant and might benefit from intensified RT.

Conclusion

Physiological changes in LNs represented by changes in ADC evaluated using DWMRI are profound sooner than the morphological changes calculated from T2w MRI. The decisions for adaptive re-planning may need to be individualized and should be based primarily on tumor functional information.

Repeated diffusion MRI reveals earliest time point for stratification of radiotherapy response in brain metastases.

Conclusion

ADC derived using high b-values may be a reliable biomarker for early assessment of radiotherapy response for brain metastases patients. The earliest response stratification can be achieved using two DW-MRI scans, one pre-treatment and one at treatment day 7–9 (equivalent to 21 Gy).
Conclusion
• N=6 patients (3 HN and 3 Sarcoma)
• The tumor ADC values changed throughout therapy: ranging response of 40% drop in ADC to gradually increasing ADC throughout RT.
• Consistent brainstem ADC indicates acceptable reproducibility of technique on a 0.345 T MRgRT system.
• Larger patient cohort studies are warranted and may enable response-guided adaptive radiotherapy.

Summary
1. Daily imaging and careful patient positioning during MRI-guided radiation therapy enables tumor response assessment during RT.
2. The magnitude and frequency of occurrence of tumor volume changes during RT vary between diseases.
3. While MRgRT shows volume changes, clinical trials are needed to determine effective forms of intervention.

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