How Diffusion Weighted Imaging Helps in Lung Cancer Radiotherapy Planning

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- No relevant disclosures
**Introduction**

- Computed Tomography (CT) is the routinely used imaging modality for lung cancer diagnosis, staging and radiotherapy (RT) planning along with 18FDG PET
- Magnetic Resonance Imaging (MRI) is not routinely used for evaluating lung cancer
- Recent data shows growing role of MRI in lung cancer management due to development of newer faster sequences and better contrast resolution
Learning objectives

- Are there any advantages of DWI sequence for radiotherapy planning as compared to CT, PET/CT and other MRI sequences?

- What are the limitations of DWI in lung cancer imaging and radiotherapy planning?
Radiotherapy for lung cancer

- In resectable cases, surgery is the treatment of choice for managing lung cancer.

- Current standards of treatment for locally advanced inoperable non small cell lung cancer (NSSLC) are:
  - Radiotherapy
  - Combined Chemoradiation

- Studies have shown increased average median survival of 21 months with radiotherapy +/- chemotherapy.
Radiotherapy for lung cancer

• Some newer techniques can provide focused radiation with decrease toxicity as compared to older techniques, including
  – IMRT (Intensity modulated radiotherapy)
  – SBRT (stereotactic body radiotherapy)

• Local control of disease with SBRT in early stage inoperable NSCLC upto 89% of cases (2)

• Imaging plays an important role in selecting appropriate patients for RT planning and also pre-RT contouring
Radiotherapy for lung cancer

- Defining tumor margin is an important factor for RT planning.
- Currently CT and FDG-PET/CT are the standard for defining tumor margin and volume for radiotherapy planning.
- However, superior contrast resolution and technical advancement of MRI can help identifying tumor margin and volume more accurately than other imaging techniques.
- Functional information can be achieved with DWI.
Diffusion Weighted Imaging (DWI)

- DWI sequence is based on brownian motion of water molecules within a voxel of tissue

- Tissues with dense cellularity (e.g. NSCLC) will have less brownian motion of water molecules causing restricted diffusion

- Restricted diffusion appears as bright signal intensity on DWI images

- However, ADC (Apparent Diffusion Coefficient) map is helpful at the same time to exclude DWI brightness due to true restriction vs T2 shine through
Large right lower lobe mass – DWI

- Pre radiotherapy planning MRI for right lower lobe mass
- Mass is mildly hyperintense on DWI image with restricted diffusion (white arrows). Central necrosis is showing T2 shine-through (yellow arrows) suggesting facilitated diffusion
Post radiotherapy changes – DWI

- T2 shine-through (yellow arrows) in the left perihilar post radiotherapy changes. Hyperintensity on first (DWI) image is not due to restriction (as also hyperintense on ADC image). In general, recurrent tumors show restriction and post radiotherapy changes show facilitated diffusion.
Recurrent NSLCC with right supraclavicular lymph node

- Pre radiotherapy planning MRI for right supraclavicular recurrent lymph node (LN)
- Mildly hyperintense LN on DWI image (white arrow)
- ADC map showing restricted diffusion (yellow arrow)
DWI vs FDG-PET for radiotherapy planning

- Recent literature comparing FDG-PET validated similar diagnostic ability of DWI in terms of T and N staging of NSCLC (3,4,5,6)

- A recent study shows agreement between FDG-PET and MRI based gross tumor volume evaluations (7)

- A meta analysis of NSCLC have shown equally accurate result of DWI and FDG-PET in mediastinal and hilar staging (8)
Left lower lobe recurrent tumor showing restricted diffusion corresponding to increased uptake seen on PET/CT fused image. Restricted diffusion is clearly separate from the post RT changes (showing facilitated diffusion).
DWI vs FDG-PET for radiotherapy planning

- DWI may become a suitable alternative to FDG-PET for radiotherapy planning in patients with NSCLC

- Advantages of DWI over FDG-PET –
  - Relatively fast sequence and shorter study time
  - Less patient preparation
  - No radiation
  - Availability
  - Cost effectiveness
DWI technique

• Currently, DWI is an added sequence to other sequences

• We routinely scan our patients on a 3 Tesla scanner

• We use a single-shot echo planar diffusion-weighted sequence with following parameters –
  – TR = 800 – 1300 ms
  – TE = 60 – 70 ms
  – averages = 3
  – slice thickness 3 – 5 mm
  – FOV = 250 x 400 mm
  – b-values at b = 0 and b = 800 s/mm2
Tumor contour

• In our institution we routinely use CT and FDG-PET for contouring lung cancer before RT planning

• MRI helps in confusing cases where tissue characterization is not helpful with CT or FDG PET

• MRI is also helpful imaging brachial plexus in patients with Pancoast tumor

• DWI is complimentary to other sequences and sometimes helps identifying tumor margin when there is a confusion with other basic sequences
Left hilar recurrent disease in a patient with prior history of adenocarcinoma treated with lobectomy

RT planning contouring
Left lower lobe recurrent tumor is difficult to differentiate from adjacent radiotherapy (RT) changes on routine CT and T2 MRI DWI & ADC showing tumor with restricted diffusion separate from the post RT changes (showing facilitated diffusion)
Contouring was performed depending on the DWI sequence
Limitations of DWI for radiotherapy planning

- DWI is not helpful for small size tumors (< 1 to 2 cm)
- Difficult to assess DWI without adequate breath hold
- Infection associated with tumor may also show restricted diffusion (similar to increased uptake on FDG-PET)
- Ground glass tumors may not show restricted diffusion
Conclusion

• DWI is a promising MRI sequence for diagnosis and radiotherapy planning of NSCLC

• To further validate, we need prospective randomized controlled studies evaluating safety and efficacy of DWI for radiotherapy planning in NSCLC

• For present day practice, if MRI is used for radiotherapy planning close look at all the sequences necessary while contouring a tumor
References


Thank you for your time.
Please don’t hesitate to contact us if you have any questions/queries.

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