Leaning objectives

- To understand the basic principle of DCE-MR techniques and interpretation of findings
- To learn the hemodynamic characteristics of H&N cancer and post RT changes
- To learn how to interpret quantitative parametric values of DCE-MR in patients with H&N cancer

What is DCE-MR?

- Dynamic acquisition of fast T1 based MR sequences to detect signal increase following Gd injection in order to measure the rate of contrast leak from plasma into the extracellular extracellular space (EES)

DCE – MR Perfusion

- DCE MR has been applied to various tumors in body: Brain tumor, Breast, and Prostate
- DCE-MR imaging allows us to assess blood flow, integrity (leakiness) of tumor vessels, and EES volume (Ve)
- Hemodynamic information on DCE MR: potential biomarker for angiogenesis & hypoxia
- Prediction and assessment of treatment response
- Changes in Ktrans, surrogate of anti-angiogenesis Rx response, potential implications for IMRT
DCE MR

• Dynamic fast 3D T1 weighted SPGR type sequence before, during, and after iv injection of Gd contrast
• Measure T1 relaxivity changes 2 to Gd leakage in and out from plasma space to EES – hemodynamic physiologic information
• Quantitative vs Qualitative analysis
• Critical information for quantitative assessment
  – Baseline T1 mapping
  – AIF
  – Concentration of Gd

DCE MR Protocol: H&N cancer

MR unit: Phillips 3T, NV-16
Native tissue T1 map: Variable FA (2, 5, 10, 15, 20, 30), NEX =2
DCE imaging:
T1 w 3D Fast Field Echo (FFE) imaging (FSPGR, FISP/FLASH)
TR/TE: 5.5/1.3 msec., Flip angle 25°
Slice thickness/Gap: 6 mm/3 mm, 20 level slices, 100 frames
Time resolution: 2.6-3.4 sec/ frame
Scan time: 4 min. 17 sec.
Contrast material: Single dose of Gd administered at 3 ml/sec
Start acquiring images before injection of Gd agent

Data analysis

• Semiquantitative
• Quantitative analysis

Semi-quantitative analysis

61y.o. male with base of tongue cancer

Left palatine tonsil SCC
TIC curve analysis

- No requirement for AIF and Model Free
- Characteristic hemodynamic patterns for Ca, Benign lesions, and post RT changes
- No clear physiological correlates- microcirculation and tissue properties

LN Metastases

Right metastatic LN & Left benign LN

Higher peak and rapid wash out for benign lymph nodes
### Table III. Comparison of USG-guided FNAB and DCE-MRI results in the detection of carcinomas in thyroid nodules

<table>
<thead>
<tr>
<th>USG-guided</th>
<th>DCE-MRI</th>
<th>FNAB</th>
<th>P value (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (%)</td>
<td>98</td>
<td>80</td>
<td>.001 (χ² = 15.36)</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>88</td>
<td>90</td>
<td>.006 (χ² = 6.65)</td>
</tr>
<tr>
<td>Accuracy (%)</td>
<td>91</td>
<td>90</td>
<td>.001 (χ² = 6.22)</td>
</tr>
<tr>
<td>PPV (%)</td>
<td>95</td>
<td>93</td>
<td>.001 (χ² = 17.25)</td>
</tr>
<tr>
<td>NPV (%)</td>
<td>98</td>
<td>92</td>
<td>.004 (χ² = 8.82)</td>
</tr>
</tbody>
</table>

Delayed washout is seen in all thyroid ca
No Rapid washout was seen in thyroid ca

Tunca F, et al. Pre-operative evaluation of thyroid ca in patients with multi-nodular goiter: DCE MR vs USgNA
Surgery 2007

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### Quantitative analysis

- With T1 map and AIF, quantitative assessment of various biomarkers are feasible in H&N cancer
- FDA approved software with automatic AIF applicable to H&N cancer commercially available
- Need to test reproducibility, reliability, consistency across multiple institutions
- MICHANIC: Multi-Institutional Collaborative H&N Imaging Consortium – ASHNR / RSNA

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A 57 M with T2N3bM0 undifferentiated NPC, Multiple metastatic LNs in right level II and III

DCE Parametric maps show higher \( K_{trans} = 0.26/\text{min}) \), \( K_s \) and AUC, respectively.

CT at 6 months post CRT demonstrate favorable response to treatment

Gaddikeri S, Ansel Y: AJNR in press

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Can DCE-MR predict Treatment Response for patients with advanced H&N SCCA?
A 52 M with SCCs of R tonsil with metastatic right level II LNs with ECS DCE Parametric maps show lower $K_{trans}=0.06/min$, $K_{ep}$ and AUC, respectively.

Gd enhanced axial T1W at 12 months post CRT demonstrate un-favorable response to treatment [E].

DCE MR to predict treatment response

- Favorable response
  - High BF
  - High Ktrans (perfusion)
  - High Ve (EEs)

- Poor response
  - Low BF
  - Low Ktrans (perfusion)
  - Low Ve (EEs)

MRI date: April 2013

64 Y male with T4bN1M0 right tonsil SCC, P16+. Completed CRT May 2013

67 Y male with T4N3M0 BOT SCC. Post right neck dissection with flap reconstruction and CRT. Tumor recurrence inferior to the flap

11 Pts w HNC DCE MR and F18/FDG PET Lower Ktrans median, Ktrans Skewness, Kep median -> hypoxia on F MISO PET

Hypoperfusion -> Hypoxia
**Summary: DCE-MR for H&N cancer**

- **DCE-MRI**: address tumor micro-vascular circulation & permeability: beyond morphology
- **Ktrans reflects both perfusion & permeability**
- **Higher Ktrans, Ve, Kep, Ktrans**: delivery of oxygen and drug, appear to reflect better prognosis
- **Skewness of Ktrans**: poor prognosis
- **DWI**: Cellular density and membrane stability