Diffusion weighted imaging in the Head and Neck

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Diffusion Weighted Imaging

- Imaging of diffusion of water molecules
- Strong gradients in 3 orthogonal directions
- $b$ value - Degree of diffusion sensitization
  - Strength
  - Duration
  - Interval between gradients

ADC (Apparent diffusion coefficient)

- Expressed in $\text{mm}^2 / \text{s}$
- Higher the ADC, more is the degree of motion (and vice versa)

Disclosures

No relevant financial disclosures

Learning objectives

- Technical aspects
- Clinical applications
- Challenges
**Diffusion Weighted Imaging**

- **Surrogate marker for cellularity**

  - Less cellularity → Higher ADC
  - More cellularity → Lower ADC

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**DWI neck - technique**

**ECHO-PLANAR IMAGING**

- **Single shot**: Limited spatial resolution, greater geometric distortion, shorter acquisition
- **Multi shot**: Higher resolution, reduced geometric distortion, longer acquisition

**Technical aspects**

**Clinical applications**
CLINICAL APPLICATIONS

Benign vs. malignant lesions

Pleomorphic adenoma parapharyngeal space

T2-weighted Pre-Gad T1-weighted Post Gad T1-weighted

ADC = 1.5 x 10^{-3} mm^{2}/s

Adenocarcinoma

ADC = 0.7 x 10^{-3} mm^{2}/s

19 y/o female with LE tingling and numbness

Venous vascular malformation

Neuroendocrine cancer

ADC = 0.75 x 10^{-3} mm^{2}/s
Benign vs malignant lesions

- Benign lesions - ADC > 1.5
- Malignant lesions - ADC < 1.0
- ADC value of $1.3 \times 10^{-3}$ mm$^2$/s at 3T - threshold value for differentiation

65 y/o M with stridor and laryngeal mass

- 65 y/o M with stridor and laryngeal mass
- b1000 diffusion ADC map
- High ADC - Chronic inflammation
- ADC = $1.5 \times 10^{-3}$ mm$^2$/s

Mucoepidermoid carcinoma

- Mucoepidermoid carcinoma
- ADC = $1.5 \times 10^{-3}$ mm$^2$/s

CLINICAL APPLICATIONS

- Benign vs. malignant lesions
- Post-therapy changes vs. recurrence
- Prediction of therapy
- Monitoring of response

POST-THERAPY

- Patient 1
- T1-w
- Post-Gad T1-w
- Enhancing mass
- Patient 2
- T2-w
- Post-Gad T1-w
- Enhancing mass

Miscellaneous
ADC can be helpful in differentiating residual or recurrent tumor from post therapy changes

- Residual or recurrent tumor: ADC decreases
- Post-therapy changes: ADC increases

ADC of $1.30 \times 10^{-3} \text{ mm}^2/\text{s}$ as a threshold

CLINICAL APPLICATIONS

- Benign vs. malignant lesions
- Post-therapy changes vs. recurrence
- Prediction of therapy
- Monitoring of response

Miscellaneous
**PREDICTION OF RESPONSE**

**PRE-TREATMENT ADC**

<table>
<thead>
<tr>
<th>COMPLETE responders</th>
<th>PARTIAL responders</th>
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<tbody>
<tr>
<td>$1.04 \times 10^{-3}$ mm²/s</td>
<td>$1.35 \times 10^{-3}$ mm²/s</td>
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- Significant increase in ADC in complete responders within 1 week of treatment
- Prediction of response: Pre-Rx ADC and change in ADC

**Diffusion image**

$ADC = 0.8 \times 10^{-3}$ mm²/s

**INTRA-THERAPY**

- ADC - Monitoring early therapeutic response
- Increase in ADC during early phase of therapy relative to baseline value suggesting conversion of solid tumor to necrotic tissue

**INTRA-THERAPY**

$ADC = 1.4 \times 10^{-3}$ mm²/s

**CLINICAL APPLICATIONS**

- Benign vs. malignant lesions
- Post-therapy changes vs. recurrence
- Prediction of therapy
- Monitoring of response
- Recurrent cholesteatoma

**Miscellaneous**
Recurrent Cholesteatoma + Scar

b1000 diffusion ADC map

Post mastoidectomy for cholesteatoma

Post-Op for petrous apex cholesteatoma

Recurrence Cholesteatoma + Scar

CLINICAL APPLICATIONS

Benign vs. malignant lesions

Post-therapy changes vs. recurrence

Prediction of therapy

Monitoring of response

Recurrent cholesteatoma

Miscellaneous

Evaluate brain metastases

Intraocular abscess
Extracranial and brain metastases

Technical aspects
Clinical applications
Challenges

Challenges with DWI neck

Susceptibility artifacts
Reduction strategies:
- Parallel imaging
- Minimize echo train length (duration of recording)

Motion from pulsation and swallowing
Minimize imaging time
- Patient instructions
- Single shot SE Echo-planar

Geometric distortions at root of neck

Summary

Pre Rx neck cancer
- Low ADC pre-Rx
- Increasing ADC during early Rx
- Positive response to chemorad

Post Rx neck mass
- Low ADC
- Recurrent or residual tumor
An Integrated Multimodality Approach

- Always interpret diffusion imaging along with anatomic information

ALLERGIC FUNGAL SINUSITIS