New Imaging Modalities Essential For Accurate Diagnosis Of Vascular Malformations

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VEITH Symposium, New York, November, 2015

Imaging Modalities

- Critical information when performing imaging on CVMs:
  - Lesion extent
  - Flow characteristics (high vs low)
  - Relationship to normal/vital structures
    - Vascular
    - Non-vascular (nerve, muscle, bone)

Imaging Modalities

- Multiple non-invasive imaging modalities are available for the diagnosis of congenital vascular malformations (CVMs):
  - Ultrasonography (US)
  - Computed tomography (CT)
  - Standard magnetic resonance imaging (MRI)

Imaging Modalities

- Each of these traditional modalities has a role, and yet each has limitations with regard to the critical information:
  - Variable degrees of diagnostic accuracy
  - Frequently insufficient information with regards to pre-procedural planning
  - Significant number of patients who required evaluation with a catheter based angiography to determine flow characteristic

Ultrasonography

Venous malformations demonstrate mixed (or monophasic) waveform on US
**Lymphatic malformations**

Lymphatic malformations demonstrate absence of flow signal on US.

**Arterio-venous malformations**

Arterio-venous malformations demonstrate arterialized venous waveform and spectral broadening.

**Coronal T2-weighted MRI**

Coronal T2-weighted MRI demonstrates hyperintense signal in the venous malformation involving the anterolateral aspect of the right upper extremity.

**Axial T2-weighted MRI of the same patient**

Axial T2-weighted MRI of the same patient.

**MRI demonstrates hyperintense T2 signals in a multiseptated, extensive lymphatic malformation in a newborn**

**T1-weighted fat-saturated gadolinium-enhanced imaging of arterio-venous malformation reveals multiple flow voids (arrow)**
**MRI - Conventional**

- used not only for evaluation of a lesion but for the evaluation of deep venous system since the prevalence of deep venous system anomalies is high in CVM patients.

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**Imaging Modalities - Limitations**

- US is useful for the initial assessment of CVMs.
- Does not give information about extent of CVMs and relationship to surrounding anatomical structures.
- Operator dependent.
- Conventional MRI and/or CT can demonstrate the extent of larger lesions.
- However, it is not adequate to differentiate between different types of CVMs in more complex cases.

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**Static MR Angiography**

- Static coronal images → 3D MIP

- Time-Resolved MRA Acquisition

  - Arterial phase
  - Venous phase

  - ROBUST HEMODYNAMIC DATA and relationship to vital structures

  - Courtesy of Charles Kim, MD
**Arterial Phase**

Arterial phase image demonstrates no vascular abnormality = LFVM

**Early venous phase**

**Late venous phase**

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**Arterial phase image demonstrates no vascular abnormality = LFVM**

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**Absence of the appearance of the malformation during the arterial phase of the maximum intensity projection time-resolved imaging is confirmatory for a low-flow lesion**

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**dceMRI demonstrates a lesion during the arterial phase what confirms a large HFVM involving the lateral aspect of the proximal upper extremity**

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**Inconclusive dceMRI**

- In inconclusive cases, confirmatory arteriography is required.
- Especially in cases in which treatment is deemed necessary.

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**Inconclusive dceMRI > Arteriogram**

- Arteriography is performed
  - to confirm the diagnosis
  - also to identify the communication pattern with the draining venous system
  - to provide an opportunity for treatment planning and/or intervention
**Our Experience**

- **Evaluation of dceMRI:**
  - 122 patients
  - Aged <1 to 70 years
  - 52 males (42.6%)
  - 70 females (57.4%)
  - 68 patients who underwent dceMRI also had a confirmatory imaging/procedure

- **Diagnostic modalities** satisfied by the frequency utilized by Duke Multi-D Vascular Malformation Team

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**dceMRI Accuracy**

<table>
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<th>Confirming modality</th>
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<th>Low Flow</th>
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<tr>
<td>Total</td>
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</table>

**dceMRI Accuracy (Dr. Kramer)**: 83.8%

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**Is dceMRI the imaging modality of choice?**

- Differentiate between high flow and low flow lesions: ✔
- Determine relationship between the VM and adjacent structures: ✔
- Confer minimal risk to patient: ✔

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**Summary**

- Diagnostic algorithm with novel imaging techniques (dceMRI) optimizes imaging of CVMs.
- dceMRI has been validated as clinically applicable for making an accurate anatomical and hemodynamic diagnosis of CVMs.
**Summary**

- dceMRI avoids unnecessary diagnostic arteriograms in majority of cases.
  - Patients can be spared the expense, risk, and inconvenience of a catheter-based diagnostic study, as well as delayed or erroneous diagnosis.

**Summary**

- Detailed, step-by-step description of diagnostic protocols available in:

**IUA Diagnostic Guidelines-2014**

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**Thank You!**