MAGNETIC RESONANCE INNOVATIONS, INC.
DEDICATED TO THE DEVELOPMENT OF NOVEL IDEAS IN MAGNETIC RESONANCE IMAGING
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SUMMARY REPORT OF FULL TECHNICAL FINDINGS

Anatomical and Vascular Abnormalities to be discussed include[1-2]:

- Carotid arteries, vertebral arteries, jugular veins, external jugular veins, anterior jugular veins, vertebral veins, deep cervical veins, vertebral plexus, facial veins and thyroid veins. These would be evaluated at C2/C3 and C5/C6 using both the 3D CE MRAV and the 2D TOF MRV data.
- Presence of stenoses, truncular venous malformations, bad valves, etc.
- Dural sinus abnormalities from post-contrast 3D VIBE data.

Flow[3-4]: Flow is reported from both the C2/C3 and C5/C6 levels for arteries and veins

- Summary of the total arterial and venous flow.
- The percentage of internal jugular venous flow compared to the arterial flow in that region.
- The ratio of dominant to sub-dominant jugular venous flow.
- The presence of no flow, reflux and circulatory flow. Azygous flow is reviewed at the upper and lower levels if available. Finally, CSF peak positive and negative flows are reported if available.

Conventional images:

- Basic comments regarding the presence of lesions or anomalous findings seen in FLAIR, T2WI and pre and post-contrast T1WI.

SWI analysis[5-7]:

- The presence of blood products in SWI data and any high iron content regions are noted.

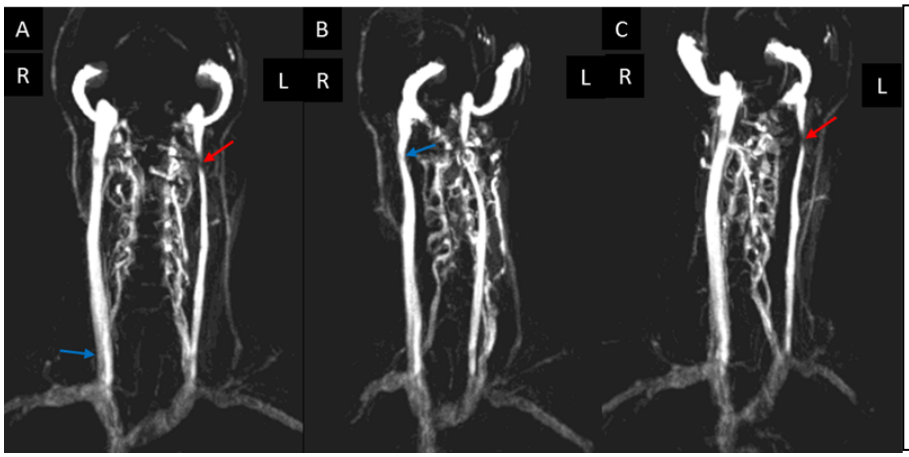

Fig. 1A-C: 3D CE MRV of the IJV

Discussion: Right IJV shows slight narrowing at the upper neck level and enhancement inhomogeneity near the confluence with the subclavian vein (blue arrows). Left IJV shows narrowing at the C2 neck level (red arrows).

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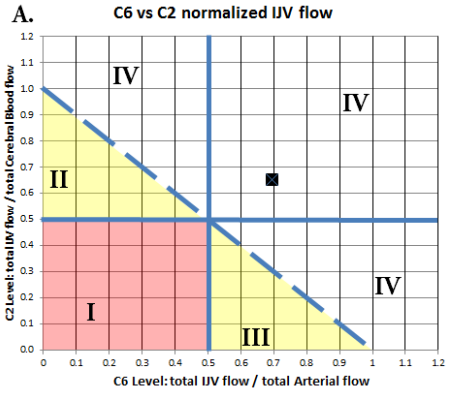

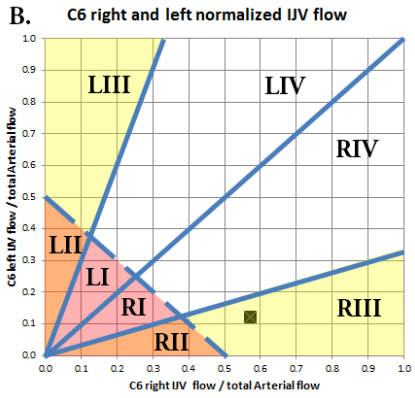

Figure 2A-B: The subject's flow lies within region IV in figure 2A; the IJV drains 65% of the total cerebral outflow at the C2-3 level and 69% of the total arterial outflow at the C5-6 level. The subject flow lies within region RIII in figure 2B; at the C5-6 level the total venous flow is 12.0 ml/s and the total arterial flow is 12.9 ml/s. The right IJV is dominant to the left IJV with a ratio of 4.8:1. The left sided collaterals carry greater flow than the right.

Figure 2A Region Legend: Region I – IJVs drain less than 50% of total arterial flow at both the C2-3 and C5-6 neck levels; Region II - IJVs drain less than 50% of total arterial flow at the C5-6 neck level and greater than 50% of total arterial flow at the C2-3 neck level; Region III – IJVs drain less than 50% of total arterial flow at the C2-3 neck level and greater than 50% of total arterial flow at the C6 neck level; Region IV – IJVs drain greater than 50% of total arterial flow at both C2-3 and C5-6. There is some evidence that most normal control subjects have flow at both C2-3 and C5-6 greater than 50%.

Figure 2B Region Legend: "R" regions have right IJV dominance. "L" regions have left IJV dominance. Region I – IJVs carry less than 50% of total arterial flow at the C6 neck level and the ratio of right to left IJV flow is less than 3:1; Region II – IJVs drain less than 50% of total arterial flow and the ratio of right to left IJV flow is greater than 3:1; Region III – IJVs drain greater than 50% of total arterial flow and the ratio of the right to left IJV is greater than 3:1; Region IV – IJVs drain greater than 50% of total arterial flow and the ratio of the right to left IJV is less than 3:1. There is some evidence that most normal control subjects lie in Region IV in Figure 2A and Region LIV and RIV in Figure 2B.

	Circulatory flow	Bulk reflux	Low flow/%CC	Pattern
C5-6 RIJV	☑	☑	☐	flat
C5-6 LIJV	☐	☐	☑ 14%	bi-modal
C2-3 RIJV	☐	☐	☐	bi-modal
C2-3 LIJV	☐	☐	☑ 32%	bi-modal

Table 1:

Additional Notes: Paraspinal network and left EJV act as collaterals. Common facial veins bilaterally drain to IJVs respectively.

Azygos vein carries 0.32 ml/s flow. CSF peak fill <1 ml/s, flush peak <2 ml/s.

Iron content of deep gray matter in normal range.

Table 1 Legend: Circulatory flow represents a retrograde flow component. Bulk reflux is the percent of the magnitude of vessel flow toward the brain divided by the sum of the magnitudes of vessel flow toward the brain and vessel flow toward the heart. Low flow is the percent of the CDC in which the vessel flow is less than 1ml/s. Pattern gives a description of the flow characteristic through one cardiac cycle.

Reference List:1) Haacke EM et al. The role of venous abnormalities in neurological disease. Rev Recent Clin Trials 2012. 2) Zivadinov R et al. Use of MR venography for characterization of the extracranial venous system in patients with MS and healthy control subjects. Radiology 2011; 258: 562-70. 3) Haacke EM et al. Patients with multiple sclerosis with structural venous abnormalities on MR imaging exhibit an abnormal flow distribution of the internal jugular veins. J Vasc Interv Radiol 2012; 23: 60-8 e1-3. 4) Feng W. et al. Quantitative flow measurements in the internal jugular veins of multiple sclerosis patients using MRI. Rev Recent Clin Trials 2012. 5) Reichenbach, JR et al. Small vessels in the human brain: MR venography with deoxyhemoglobin as an intrinsic contrast agent.JMRI. 1997;7:963-71. 6) Haacke EMet al: Characterizing iron deposition in multiple sclerosis lesions using SWI. JMRI 2009; 29: 537-44. 7) Habib CA, et al. Assessing abnormal iron content in the deep gray matter of patients with multiple sclerosis versus healthy controls. AJNR 2012;33:252-8.