MR-Guided Treatment of Low-Flow Vascular Malformations

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Target audience: This study targets radiologists who have a general interest in interventional MRI as well as those who have an interest in studying and treating venous (VM) and lymphatic malformations (LM).

Purpose: Low-flow VM and LM are traditionally treated using ultrasound and fluoroscopy guided percutaneous sclerotherapy. However, certain lesions are particularly difficult to visualize and/or treat using these modalities. Real-time MR-guided intervention may serve as a safer alternative with better visualization of surrounding critical soft tissue structures and with less or no exposure to ionizing radiation.[1,2,3] We present here our experiences with targeting and treating VM and LM using real-time MR imaging.

Methods: Patients with VM or LM were enrolled into this IRB approved study between 9/2010 and 7/2014. Each patient was selected for MR guidance for actual or predicted inability to find the lesion using ultrasound. Imaging was conducted with a MAGNETOM Espree 1.5T MR scanner (Siemens Healthcare, Erlangen, Germany) and an AXIOM Artis dFA floor-mounted angiography system (Siemens Healthcare, Forchheim, Germany) "Miyabi" suite. After planning MR (3mm T2 TSE SPAIR), all lesions were targeted with 20 or 22 gauge MR-compatible needles (Cook, InVivo, E-Z-Em) ranging from 5-20 cm in length using real time MR guidance with Interactive Real-Time TrueFISP imaging (BEAT_IRTTT, Siemens Corporate Technology, slice thickness 4mm, 465 ms per slice), HASTE acquisition (slice thickness 4mm, ~750 ms per slice), or a custom-made T2-Weighted Steady State Free Procession (CP-SSFP) sequence.[3] Once access was confirmed by fluid return, confirmatory T2 TSE sequences were acquired. When indicated, patients were transferred to the in-room Artis where a direct injection of ioxilan 350 (Guerbet) was used to confirm MR findings. Patients with VM were treated with anhydrous 100% ethanol, gadolinium-doped 5% ethanolamine oleate, or gadolinium-doped 3% sodium tetradecyl sulfate. Patients with LMs were treated with doxycycline (10mg/cc). After treatment, confirmatory imaging was conducted (3mm T2 TSE SPAIR or 3mm 3D VIBE).

Results: 23 patients were enrolled in this study with an age range of 8-61 years old. Several patients underwent repeat treatments for a total of 35 cases and 71 attempted lesions (66 LM, 4 VM, 1 hindgut cyst). 61 of the 71 lesions were accessed and treated. The average total procedure time for all procedures was 2:19:51 (hours:minutes:seconds; σ = 0:44:52). There was a difference of 1:15:07 ($p = 0.022$) between the average total procedure time for the first 6 cases (3:14:15, σ = 1:04:35) and the last 6 cases (1:59:08, σ = 0:32:12). The average "skin-to-skin" time (interval between needle skin puncture and needle removal) for all procedures was 1:09:46 (σ = 0:42:40). There was a difference of 1:11:54 ($p = 0.010$) between the average "skin-to-skin" time for the first 6 cases (2:02:51, σ = 1:01:00) and the last 6 cases (0:50:57 (σ = 0:18:53). The average planning time for all procedures was 1:10:05 (σ = 0:19:38). There was a difference of 0:03:13 ($p = 0.394$) between the average planning time for the first 6 procedures (1:11:23, σ = 0:19:45) and the last 6 procedures (1:08:10, σ = 0:20:41). The average time to target (interval between needle skin puncture and lesion access) for all procedures was 0:08:40 (σ = 0:10:40). There was a difference of 0:14:20 ($p = 0.037$) between the average time to target for the first 6 cases (0:18:20, σ = 0:22:15) and the last 6 cases (0:04:00, σ = 0:03:50). There were no minor or major immediate or delayed complications. All of the treated patients reported reduced symptoms by 6 weeks.

Discussion: This study demonstrates that VM and LM can be treated using MR guidance with an 85.9% technical success rate. The procedure is safe, with no complications noted, and effective, with alleviation of symptoms in 100% of treated patients. An initial learning curve is noted with total procedure time, "skin-to-skin" time, and time to target all significantly decreasing over the course of 35 cases. The technical success rate, total procedure time, procedure learning curve, and treatment response with MR guidance are on par with our institutional experience with ultrasound and fluoroscopy guided procedures. Interestingly, despite alterations in planning methods and technique, planning time did not significantly change.

Conclusion: MRI provides a safe and effective option for real-time targeting and treatment of low-flow VM and LM that cannot be adequately or safely targeted using traditional ultrasound and fluoroscopy guidance. MR-guided percutaneous sclerotherapy of low-flow vascular malformations is ripe for adoption by interventional radiology practices.

References:

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