MR-GUIDED SCLEROTHERAPY OF LOW-FLOW VASCULAR MALFORMATIONS USING T2-WEIGHTED INTERRUPTED BSSFP (T2-W-iSSFP): COMPARISON OF PULSE SEQUENCES FOR VISUALIZATION AND NEEDLE GUIDANCE

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BACKGROUND Venous malformations (VMs) and lymphatic malformations (LMs) are congenital lesions that affect both children and adults. T2-weighted fat suppressed turbo spin echo imaging (T2-W-TSE) is the gold standard for diagnostic imaging of VMs and LMs, and these lesions are typically treated percutaneously using ultrasound (US) for needle insertion and fluoroscopy for assessment of flow and draining veins. However, certain lesions cannot be accessed using US. Typically these include lesions that are deep within the body, that lie beneath scar, or are located in or behind bone. Real-time MR-guided intervention serves as an alternative. However, conventional real-time sequences are limited; they are either slow, with blurry, distorted edges (HASTE) or demonstrate ambiguous malformation delineation because of poor T2-weighting (bSSFP).

PURPOSE To clinically deploy a new technique specifically designed for the visualization of VMs and LMs during real-time image guidance during intervention: T2-weighted interrupted bSSFP (T2-W-iSSFP).

METHODS Sequence design: T2-W-iSSFP is a variable flip angle interrupted bSSFP sequence. T2 contrast and fat suppression are based on T2-TIDE and FS-TIDE. A prolonged TR combines T2-TIDE and FS-TIDE, hence achieves simultaneous T2 contrast and fat suppression. T2 weighting and fat suppression are customizable with higher/lower flip angles (HFA/LFA) in the bSSFP train, respectively. Patient testing: To compare the malformation visualization, patients (N=8) were scanned by HASTE, bSSFP and T2-W-iSSFP; TSE was used as the reference of lesion detection. Evaluation imaging was performed as pre-procedural imaging, with IRB approval. To evaluate the sequence’s performance in patients, CNR efficiency (CNR of VMs vs. muscle divided by the square root of acquisition time) and image sharpness (the reciprocal of mean edge width of needles in the images of swine) were used. Further, MR-guided percutaneous needle placement procedures were carried out using T2-W-iSSFP on swine (N=3) and on VM patients (N=8). All patients had undergone prior percutaneous sclerotherapy procedures with an actual or predicted inability to access their malformations using US.

RESULTS Using TSE as the reference sequence, 14 VMs were detected. The lesion detection rates are 14/14 (HASTE), 7/14 (bSSFP) and 14/14 (T2-W-iSSFP). The evaluation of the three real-time sequences are shown in Table 1. All MR guided sclerotherapy procedures using T2-W-iSSFP were successful. Specifically, all needles (14 punctures) were placed in the targeted lesions, which was confirmed by post-insertion T2-W-TSE and post-contrast FLASH. A successful MR guided VM embolization is presented in Fig 1.

CONCLUSION T2-W-iSSFP provides effective lesion identification and needle visualization. Using this sequence in MR-guided sclerotherapy, we successfully treated eight patients, which are all difficult cases. This sequence has potential use in other MR-guided procedures where heavily T2-weighted real-time images are needed, such as liver biopsy, nephrostomy, and biliary drainage.