3 Tesla MR-guided Scalene Muscle Injections in Patients with Neurogenic Thoracic Outlet Syndrome

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Purpose

Neurogenic thoracic outlet syndrome is often caused by brachial plexus compression in the scalene triangle and costoclavicular space. As such, the anterior and middle scalene muscles are the principle targets for intramuscular diagnostic and therapeutic injections. While ultrasound and CT guidance are often employed techniques, MRI guidance combines cross-sectional imaging with high soft tissue contrast, absence of ionizing radiation, and the ability to visualize injectants without a contrast agent. The purpose of this report was to assess the feasibility and technical outcome of 3T MR-guided intramuscular injections of the anterior and middle scalene muscles in patients with neurogenic thoracic outlet syndrome.

Methods

75 consecutive patients (41 women, 34 men; median age, 37 years ; age range: 15-62 years) who underwent MR-guided intramuscular injections of the anterior and middle scalene muscles were included. Injections were performed using a 3T wide-bore MR imaging system (MAGNETOM Skyra, Siemens Healthcare). Patients were positioned supine with the head turned to the contralateral side. For identification of the scalene muscles and planning of a suitable needle path, an axial intermediate-weighted (IW) 2D TSE (TR, 4960 ms; TE, 27 ms; pixel size, 0.6 x 0.6 mm²; slice thickness (SL), 2.5 mm; receiver bandwidh (BW), 218 Hz/px; echo train (ET), 25; acquisition time (TA), 1:20 min) was used. MR-compatible fiducial markers were used to determine the needle entry site using a HASTE sequence (TR, 2000 ms; TE, 87 ms; pixel size, 0.8 x 0.8 mm²; SL, 4 mm; BW, 280 Hz/px; ET, 146; TA, 0:04 min). A 22G MR-conditional Chiba needle was used (MREye, Cook Inc., Bloomington, IN). Needle placement was monitored intermittantly with an axial high-BW 2D TSE (TR, 2500 ms; TE, 20 ms; pixel size, 0.6 x 0.6 mm²; SL, 3 mm; BW, 490 Hz/px; TA, 0:14 min). For anterior scalene injections, volumes of 3 ml were injected, whereas volumes of 1.5 ml were injected into the middle scalene muscles. The injectant was visualized using an axial, T2-weighted, high-BW HASTE sequence (TR, 2290 ms; TE, 88 ms; pixel size, 0.8 x 0.8 mm; SL, 3 mm; BW, 480 Hz/px; ET, 188; TA, 0:14 min), which were acquired before, intermittantly during, and after the injection. Outcome variables included technical success, which was defined as MRI visualization of the injectant inside the target muscle with no spread to the brachial plexus, major complications, defined in accordance with the Society of Interventional Radiology guidelines, and the total procedure time, defined from acquisition of the first MR image to the last MR image.

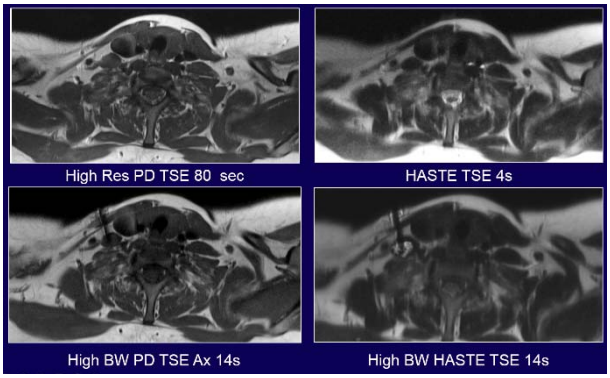

Figure: 3T MR-guided right anterior scalene muscle injection in a 34-year-old woman using a 2D TSE sequence (left upper) for visualization of the anatomy and planning of the needle path, a rapid 2D HASTE sequence (right upper) for determination of the skin entry point, a high-bandwidth 2D TSE sequence for visualization of the needle (left lower), and a rapid 2D HASTE sequence for visualization of the injectant (right lower).

Results

Procedures were completed in 74/75 patients, whereas in 1/75 patients, the procedure was prematurely terminated due to a panic attack. In 70/74 patients, the anterior scalene muscle was targeted (70 injections), whereas in 4/74 patients, the anterior and middle scalene muscles were targeted (8 injections). In 78/78 targets, intramuscular needle placement and intramuscular injection were successfully achieved. In 5/78 injections there was additional extramuscular spread, whereas two of those cases demonstrated contract with the brachial plexus and subsequent signs of plexus anesthesia. No major complications occurred. Three minor complications included one hematoma and in two cases, a temporary Horner syndrome occurred, which resolved within 18 hours. The average total procedure time was 20 min (12 – 48 min).

Discussion

We report our experience of a large series of consecutive MR-guided scalene muscle injections at 3T. The high soft tissue contrast affords the differentiation of the anterior and middle scalene muscles, brachial plexus, and close by veins and arteries. The high signal to noise ratio of interventional MRI at 3T can be utilized for rapid temporal and high spatial resolution. The combination of a MR-conditional needle and high-bandwidth TSE sequences results in excellent visibility of the injection needle with accurate representation of the needle tip. In addition to the absence of ionizing radiation, a heavily T2-weighted HASTE sequence enables rapid visualization of location and spread of the injectant for an objective assessment of the test validity, as the detection of spread to the brachial plexus is crucial to qualify a result as false positive.

Conclusion

3 Tesla MR-guided scalene muscle injections are feasible and combine a high technical accuracy, a favorable safety profile, the absence of ionizing radiation, and the ability to accurately visualize the injectant without the need of a contrast agent.