

Preserving Image Quality with Ultrafast Cervical Spine MRI Using HASTE and Deep Learning–Based Reconstruction

MASAAKI MIKAMOTO (Sapporo, Japon), Hidetoshi Ono (Sapporo, Japon), Akihiro Kaneko (Sapporo, Japon), yasufumi ohtake (Sapporo, Japon)

Introduction

Ultrafast MRI techniques may reduce examination time and improve workflow in cervical spine imaging; however, potential degradation of diagnostic image quality remains a concern. Half-Fourier acquisition single-shot turbo spin echo (HASTE) combined with deep learning–based reconstruction may enable rapid cervical spine MRI while preserving clinically relevant image quality. This study compared image quality and observer agreement between ultrafast HASTE with deep learning–based reconstruction and conventional turbo spin echo (TSE).

Materials and Methods

Sixty-two adult patients underwent sagittal T2-weighted cervical spine MRI using both conventional TSE and HASTE within a single examination. HASTE was acquired with deep learning–based reconstruction with an acquisition time of approximately 7 seconds. Two independent observers performed visual assessments of primary imaging findings, anatomical delineation, and image artifacts, and interobserver and intraobserver agreement were evaluated. Quantitative image quality was assessed using signal-to-noise ratio (SNR) of the spinal cord and cerebrospinal fluid (CSF), and contrast-to-noise ratio (CNR) between CSF and the spinal cord.

Results

For primary imaging findings, including intervertebral disc degeneration, spinal canal stenosis, and intramedullary T2 hyperintensity, interobserver agreement was generally moderate to high for both sequences, with weighted kappa values in the moderate-to-excellent range. Agreement for anatomical delineation showed structure- and observer-dependent variability, with generally lower kappa values than those for primary imaging findings. Assessment of CSF flow and motion artifacts showed similar trends between sequences. Importantly, images rated as non-diagnostic were rare for both sequences, indicating preserved diagnostic acceptability even with ultrafast acquisition. Quantitative analysis demonstrated significantly higher CSF SNR (196.3 ± 105.7 vs 128.3 ± 64.1) and higher CSF–spinal cord CNR (155.5 ± 91.3 vs 88.0 ± 44.3) for HASTE than for TSE (both $p < 0.001$), while spinal cord SNR did not differ significantly between sequences ($p = 0.738$).

Conclusion

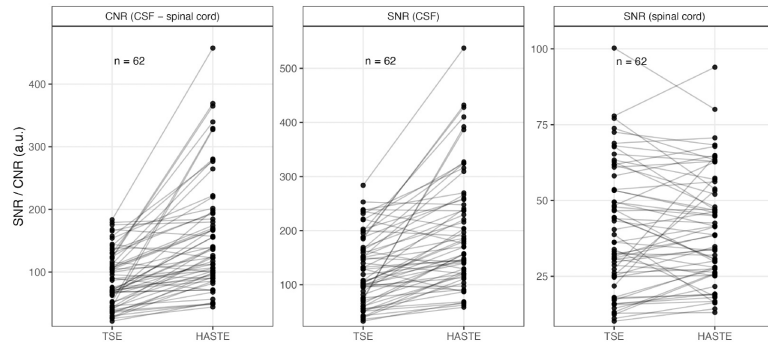
Despite a markedly shorter acquisition time, HASTE with deep learning–based reconstruction preserved diagnostic acceptability, quantitative image quality, and observer agreement comparable to those of conventional TSE, supporting its potential utility as an ultrafast sequence for cervical spine MRI screening.

Table 1. Interobserver agreement for TSE and HASTE

Item	n	TSE percent agreement (%)	TSE weighted κ	HASTE percent agreement (%)	HASTE weighted κ	McNemar p value
Primary imaging findings						
Spinal cord morphological deformation	310	80.6	0.82	85.5	0.84	0.087
Spinal canal stenosis severity	310	60.3	0.64	66.5	0.67	0.065
Intervertebral disc degeneration	310	68.1	0.79	70.0	0.76	0.602
Intramedullary T2 high signal intensity	310	96.5	0.51	99.7	0.92	0.009
Secondary assessment						
Anatomical delineation						
Spinal cord	62	66.1	0.17	50.0	0.11	0.066
Intervertebral disc	62	85.5	NC	64.5	NC	0.012
LF	62	87.1	NC	74.2	0.11	0.118
PLL	62	87.1	NC	66.1	0.07	0.016
Artifacts						
CSF flow artifact	62	74.2	0.35	75.8	0.52	1.000
Motion artifact	62	72.6	0.36	69.4	0.11	0.845

TSE = turbo spin echo; HASTE = half-Fourier acquisition single-shot turbo spin echo; LF = ligamentum flavum; PLL = posterior longitudinal ligament; CSF = cerebrospinal fluid; NC = not calculable because only a single category was used by at least one observer.

Figure 1. Quantitative image quality comparison between TSE and HASTE



Paired dot plots ($n = 62$) show contrast-to-noise ratio (CNR; CSF-spinal cord) and signal-to-noise ratio (SNR) of CSF and spinal cord. HASTE demonstrated higher CSF SNR and CNR compared with TSE, whereas spinal cord SNR was comparable between sequences.