

## MR Examination Times of Less than 8 Minutes for 4 Common Indications

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### Introduction

Recent advances in MR hardware and software such as phased-array coils with large numbers of elements, parallel imaging as well as other k-space undersampling schemes (1) enable decreased image examination times compared to older MR systems that do not have these capabilities. Decreased acquisition times are clinically of high interest in order to improve the cost-effectiveness of MR imaging. In this educational presentation we apply these advances to suggest clinical imaging protocols of less than 8 minutes for four commonly performed MR examinations (brain, cervical spine, knee and ankle). We compared objective and subjective image quality of the images obtained with these short acquisitions with images obtained with vendor-supplied protocols of 'regular' duration.

### Methods

Existing clinical MR protocols for brain, cervical spine, knee and ankle imaging were adjusted in terms of type and number of sequences as suggested within the framework of the American College of Radiology (ACR) MRI Accreditation Clinical Image Quality Guide (v2.1) imaging protocols (2). Each imaging protocol was adjusted to satisfy the minimum requirements regarding pulse sequences and image contrast as well as anatomic coverage, imaging planes and spatial resolution. Subsequently, 40 patients referred for MR imaging of the brain (n=13; 7F/6M; mean age 3.5 yrs), cervical spine (n=6; 1F/5M; mean age 53.8 yrs), knee (n=12; 3F/9M; mean age 35.1 yrs) and ankle (n=9; 5F/4M; mean age 28.8 yrs) were imaged using 1) the conventional imaging protocol at our institution, and 2) the imaging protocol optimized after application of the ACR minimum standards. All patients were imaged on a 1.5T Ingenia scanner (Philips Healthcare, Best, The Netherlands) using either the 20-element head/neck coil (brain and cervical spine), the 16-element knee coil, or the 8-element ankle coil. Parallel imaging factors used ranged from 1X (no parallel imaging) to 4X; NSA values varied between 1-2. Spatial resolution of all sequences satisfied the criteria as set forth in the ACR guide (2). After acquisitions were completed an experienced MR fellowship-trained radiologist reviewed all sequences. The radiologist was blinded for the type and acquisition duration of each sequence. Images were scored for subjective image quality, perceived SNR and artifacts (all on 5-point scales). Differences in acquisition duration as well as the scores for each of these points were compared with a paired samples t-test.

### Results

All 40 patients underwent both studies successfully. All images acquired with the ACR guide optimized imaging protocols were considered to be diagnostic quality. Examples of image quality as obtained with these fast protocols are shown in figure 1 (brain) and figure 2 (knee). After protocols were optimized scan times were reduced significantly ( $P < 0.001$ ). Mean reduction in scan time was 50% (range: 27-70%). Subjective image quality was rated slightly lower with a mean of  $4.5 \pm 0.6$  for the fast imaging protocols and  $4.8 \pm 0.4$  for the conventional protocols ( $p = n.s.$ ). Perceived SNR of the fast images was scored a mean value of  $4.1 \pm 0.6$  versus  $4.5 \pm 0.5$  for the conventional protocols ( $p = n.s.$ ). None of the fast acquisitions had disturbing artifacts. No difference was found in artifact scores ( $4.6 \pm 0.8$  versus  $4.8 \pm 0.6$ ) between the fast acquisitions and the conventional imaging protocols (figure 3).

### Discussion and Conclusions

We demonstrate that application of recent advances in MR hardware and software enable faster imaging compared to standard vendor supplied protocols. For 4 very commonly performed MR studies we were able to bring image acquisition down to less than 8 minutes, while still satisfying the criteria as set forth in the most recent version of the ACR Clinical Image Quality Guide.

### References

1. Lustig et al. MRM 2007;58:1182-95; 2. ACR MRI Accreditation Clinical Image Quality Guide v2.1 (2008)

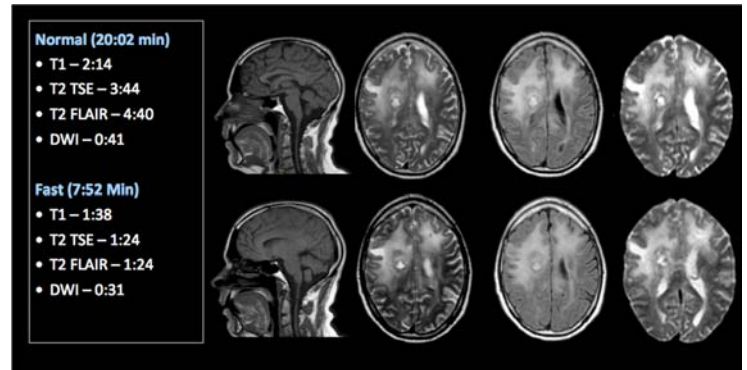


Fig. 1. Non-optimized (top row) and ACR-guide optimized imaging protocol (bottom row) for standard MR imaging of the brain. Note nearly identical appearance of image contrast and lesion conspicuity in right cerebral hemisphere. Total scan time was reduced by 60%.

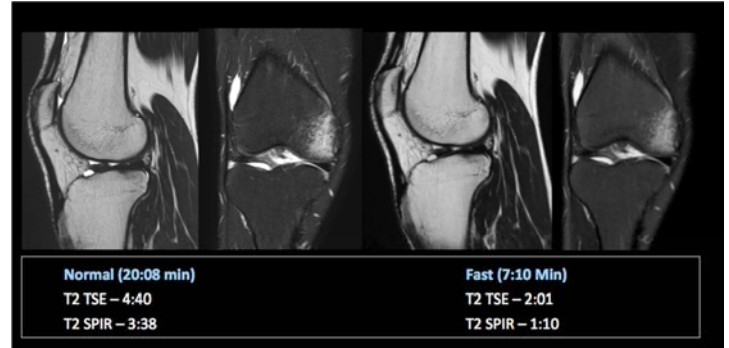


Fig. 2. Non-optimized (left two images) and ACR-guide optimized imaging protocol (right two images) for standard MR imaging of the knee. T2-weighting and spatial resolution are both slightly decreased. Despite these changes the area of bone marrow edema in the medial femoral condyle is clearly visible and of similar extent as in the non-optimized imaging protocol. Total scan time was reduced by 65%.

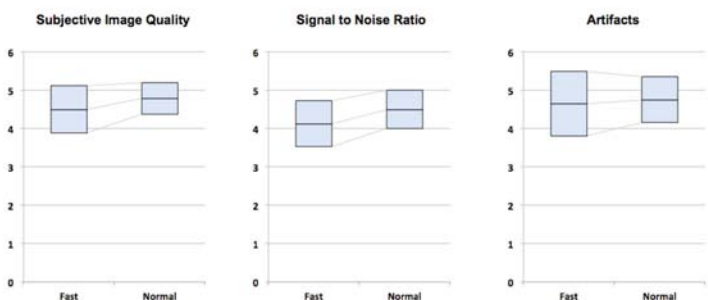


Fig. 3. Although scores for the ACR-guide optimized (fast) imaging protocols were slightly lower compared to non-optimized (normal) imaging protocols there were no significant differences with regard to subjective image quality, perceived SNR and artifacts (all  $p > 0.05$ ).