Comparative study of true steady-state free precession (true SSFP) and half-Fourier RARE sequences for fetal imaging

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INTRODUCTION

Fetal MRI represents a non-invasive imaging technique that allows a detailed visualization of the fetus in the maternal structures. Until recently, the long acquisition times of conventional MRI sequences prohibited detailed studies the fetal anatomy due to motion artifact. The advent of fast MR sequences has revolutionized the ability to visualize fetal anatomy and pathology without maternal or fetal sedation. A variety of ultra-fast sequences are currently available including echo planar, half-Fourier FSE and true fast imaging steady precession sequences. In this study, we evaluated the usefulness of true steady-state free precession (true SSFP) sequence in comparison with half-Fourier RARE.

MATERIAL AND METHODS

A total of 30 consecutive pregnant patients (19-36 week's gestation) underwent MRI at 1.5 T system (VISART/EX). MR examination were obtained using following pulse sequences: half-Fourier RARE (TR/TEeff = ∞/80, ETL = 148, ETS = 4, matrix = 256 x 256, slice thickness = 8mm, imaging time = 20sec); True SSFP (TR/TE = 5.7 - 8.6 / 3.1, flip angle = 70 - 90, matrix = 256 x 256, imaging time = 20 sec). The half-Fourier RARE imaging was performed first, and then True SSFP images were obtained in the same plane. The size of the cursor was chosen to include a large representative portion of the organ. The value of the signal intensities (SI) of the fetal organ was divided by the corresponding standard deviation (SD) of noise to derive the signal-to-noise (SNR) ratio. The SNR for fetal organs (lung, heart, liver, kidney, muscle, and cerebrum), amniotic fluid and umbilical cord were calculated. The contrast-to-noise (CNR) ratio of the organs to amniotic fluid, heart to lung and liver to kidney were calculated as | organ SI - amniotic fluid SI | /noise SD. Two radiologists who were blind to the clinical history and pathologic results performed the qualitative analysis. Initially, sets of images acquired by the two sequences were randomly presented to radiologists who independently assigned images quality scores of 1, 2, 3, 4 or 5 - representing poor, fair, equivocal, good, or excellent - for the anatomical visualization and contrast (heart to lung, liver to kidney, bone to soft tissue, amniotic fluid to umbilical cord, and amniotic fluid to fetus) and motion artifacts. Statistical analysis of quantitative data among the pulse sequences was determined by using the paired two-tailed Student ***t***-test and a P value of .05 or less was considered statistically significant. Qualitative image ranking data were compared with the Wilcoxon signed-rank test.

RESULTS

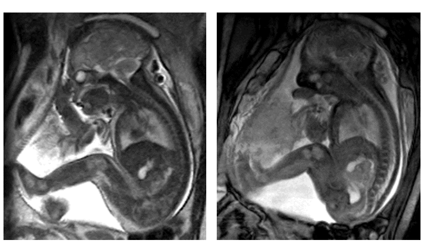
There was no statistical difference between the true SSFP and the half-Fourier RARE in the motion related artifact. Sharpness of organ contours on the true SSPF images was better than that on the half-Fourier RARE. On the true SSFP images, the mean SNR of lung was 50.4±24.1, heart (33.0±17.8), liver (30.2±15.1), kidney (56.1±27.8), muscle (33.0±16.1), cerebrum (43.0±20.1), amniotic fluid (71.5±14.1). On the half-Fourier RARE images, the mean SNR of lung was 45.4±26.1, heart (24.6±15.1), liver (30.1±13.1), kidney (45.1±22.4), muscle (32.0±15.1), cerebrum (55.3±23.1), amniotic fluid (104.5±18.1). The CNRs of both fetal organs and umbilical cord to amniotic fluid on the half-Fourier RARE images were better than those on the true SSFP (P<.05). There was no statistical difference between the True SSFP sequence and the half-Fourier RARE for the fetal liver to kidney contrast. Concerning the conspicuity of both fetus organ and umbilical cord to amniotic fluid, the half-Fourier RARE images were better than those on the true SSFP. As far as bone to soft tissue contrast, the true SSFP images were better than the half-Fourier RARE.

CONCLUSION

The true SSFP sequence generates fetal images without motion artifacts. The true SSPF images have similar organ contrast to the half-Fourier RARE except heart and umbilical cord. The true SSFP sequence may be preferable in a fetus with musculoskeletal abnormality.

Figure 1. A 36-week-gestation fetus

half-Fourier RARE true SSFP



Fisure 2. A 26-week-gestation fetus

half-Fourier RARE true SSFP