

Increased slice aliasing artifacts in MR ventriculocisternography using 3D SSFP imaging

C-W. Ko¹, T-Y. Chen², T-Y. Huang³, Y-R. Lin³, H-W. Chung³, C-Y. Chen⁴

¹Department of Computer Science and Engineering, National Sun Yat-Sen University, Kaohsiung, Taiwan, ²Department of Radiology, Veterans General Hospital, Taipei, Taiwan, ³Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ⁴Department of Radiology, Tri-Service General Hospital, Taipei, Taiwan

Introduction

Ventriculocisternography by means of T2-weighted MR imaging has long been shown effective in noninvasive diagnosis of cerebrospinal fluid (CSF) fistula or rhinorrhea (1). The 3D SSFP technique showing T2/T1 contrast is particularly suitable for this purpose, in that the signals from the parenchyma are minimized while CSF shows relative high intensity, providing clear CSF-parenchyma distinction with high spatial resolution. In this study we report our investigation of increased slice aliasing artifacts in 3D SSFP images as a function of flip angle. An optimal flip angle that reduces slice aliasing while retaining sufficient CSF-parenchyma contrast is also proposed.

Materials and Methods

An RF pulse with limited time duration results in an imperfect slice profile characterized by reduced actual flip angle at the slice boundary (2). This is particularly true for 3D SSFP imaging because of the requirements of short TR to achieve banding-free imaging. Since SSFP signals are fairly strong at moderate flip angles, the actual slice profile in SSFP imaging could become wider than expected. Slice profile calculation was performed assuming a sinc pulse without side lobes, lasting 0.9 msec and smoothed with a Hamming window. The ideal slice profile was assumed to be the flip angle distribution along the slice direction, with central value being the designated flip angle. Actual slice profile was computed as the SSFP signal along the slice direction. Percentage slice aliasing was computed as the ratio of full-width-at-half-maximum (FWHM) of the actual profile to that of the ideal profile. Designated flip angle was varied from 0° to 90°, with 70° being often recommended for ventriculocisternography.

Axial and coronal images were acquired from 7 subjects (3 patients and 4 healthy adults) on a 1.5T system (GE Signa, Milwaukee, WI) using the 3D FIESTA technique (TR/TE = 5.9/1.8, flip angle = 70°, FOV = 15cm, slice thickness = 0.8mm, bandwidth = 41.7KHz, 4 signal averages). The extent of slice aliasing was visually examined and compared with results from theoretical deduction as described above.

Results

Figure 1a shows the 11th slice (slice ordered from anterior to posterior) from a 3D FIESTA image set with 42 slices. The slice aliasing artifacts can be clearly seen for the lateral ventricles (arrows), even on an inner slice within a 3D volume (i.e., the 11th among 42 slices). The artifacts in Fig.1a correspond to the lateral ventricles at a posterior slice location, as evidenced from a posterior slice shown in Fig.1b. Results from the slice profile calculation are shown in Fig.2 for two designated flip angles, where it is seen that as flip angle increases, the actual slice profile in SSFP imaging widens. For 70° flip angle, the percentage slice aliasing is as high as 28% (Fig.3), in qualitative agreement with visual examination on the 3D FIESTA images (Fig.1). A reduction of flip angle from 70 to 40 decreases the extent of slice aliasing by more than three fold (28% to 9%, Fig.3) while reducing the CSF-parenchyma contrast by only 32% (results not shown).

Conclusion

While 70° flip angle provides conspicuous CSF-parenchyma contrast in 3D SSFP imaging, increased slice aliasing may hinder clinical image interpretation. Lowering flip angle to about 40° is a simple effective approach that substantially reduces slice aliasing with mild sacrifice in CSF-parenchyma contrast. A designated flip angle of 40° is recommended for MR ventriculocisternography using 3D SSFP imaging.

References:

1. Nakamura T et al. AJNR 2002;23:1407.
2. Wilman AH et al. MRM 2000;44:336.

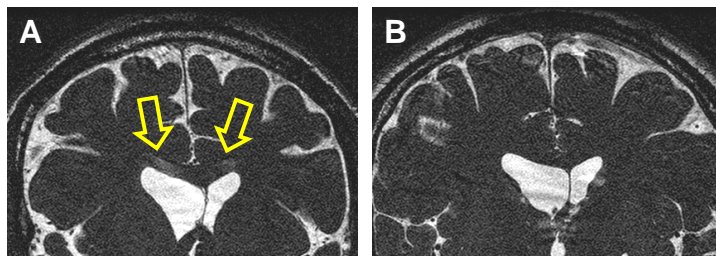


Figure 1 (up). The 11th slice from a 42-slice 3D SSFP image set (a), showing slice aliasing artifacts (arrows) from the lateral ventricles at a posterior slice (b).

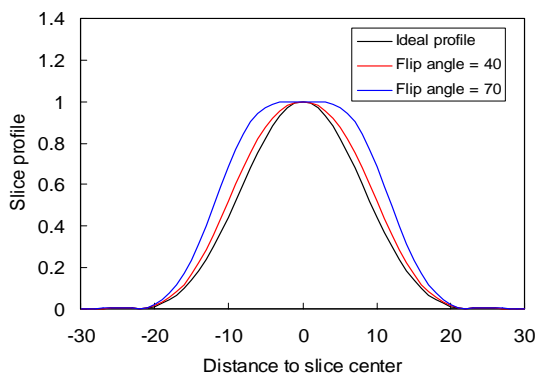


Figure 2. Ideal (black) and actual slice profiles at 40° (red) and 70° (blue) designated flip angles for SSFP imaging. Slice thickness was assumed to be 20 cm. Widened slice profile is clearly seen for 70° as compared with 40° flip angle.

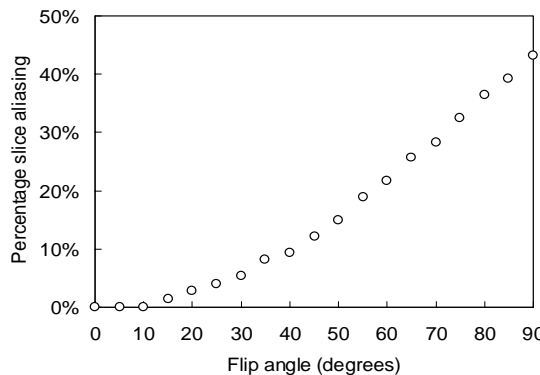


Figure 3. Percentage slice aliasing as a function of designated flip angle. The percentage slice aliasing is as high as 28% at 70°, but reduces to 10% at 40°.