Esophagus Imaging by 3D FSE with Combination of Inner Volume Excitation and Variable Refocusing Flip Angles

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Introduction

It is important to determine esophageal cancer stages before treatment in order to select the best treatment option. Assessment of tumor infiltration depth into the wall layers of the esophagus is one of the critical features of staging. 3D MR imaging is a useful tool to observe the esophageal wall structure from arbitrary orientations by reformatting, though its scan times tend to be lengthy with both a high resolution and a large volume of interest (VOI). Recently it was shown that single shot fast spin echo sequence (SSFSE) with variable refocusing flip angle design generates clinical T2 contrast without severe blurring [1]. In this study, we combined the variable flip angle design with inner volume (IV) methods and examined the contrast change of the esophageal wall layer structure.

Methods

Refocusing flip angle trains were produced to establish pseudosteady-state conditions according to [1]. In this method, individual signal targets, $S_{target}(n)$ are set for each echo n that asymptotically approaches the nominal target, S_{target}:

$$s_{target}(1) = \frac{1}{2}\left(1 + S_{target}\right)$$

$$s_{target}(n) = \frac{1}{2}\left(s_{target}(n-1) + S_{target}\right)$$

We conducted 3D FSE scan with S_{target} of 0.3, which generated contrast-equivalent TE (TE_{equiv}) of 90.5 ms with designed relaxation parameters T1 = 1000 ms and T2 = 100ms. TE_{equiv} is defined as the TE that would achieve the same relaxation by designed T2 alone as depicted by [1]. The RF flip trains were shown in Fig. 1.

We used a home made 2-channel receiver coil dedicated to the upper esophageal scan (Fig. 2). It consists of a loop element and an 8-figure element and they were overlapped to be mutually decoupled. IV 3D FSE method used 90-degree excitation pulse selective in the phase encoding direction as done by [2]. Each sequence was applied with the same voxel size of 1.17x1.17x2mm and a TR of 2.5 s with fast recovery technique. We performed all scans on a GE Signa 3T HD MR imaging system (GE Healthcare, Waukesha, WI, USA) and written consent was obtained from the two volunteers.

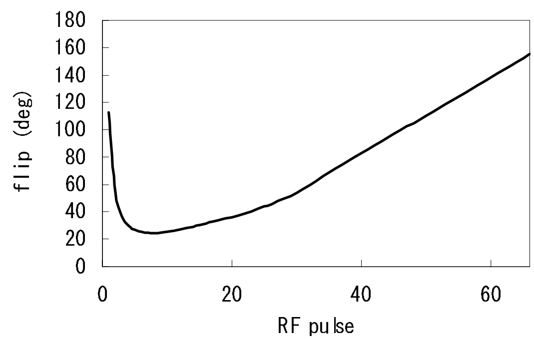

Fig. 1 Variable flip-angle series used with inner volume scan.

Fig. 2 2-channel receiver coil dedicated to esophageal imaging

Results and Discussion

Fig. 3 shows esophagus images of conventional SSFSE and IV 3D SSFSE with variable flip angles. Heavy T2 contrast was produced in the conventional SSFSE image due to the long echo train length (ETL) of 130 (effective TE = 368.6 ms). We could acquire clinical T2 weighted image (TE_{equiv} = 90.5 ms) with IV variable flip angles, and the wall layers could be recognized. The clinical T2 contrast with high signal to noise ratio was achieved by combination of the variable flip angle design and inner volume scan, which makes smaller ETL of 66 without aliasing.

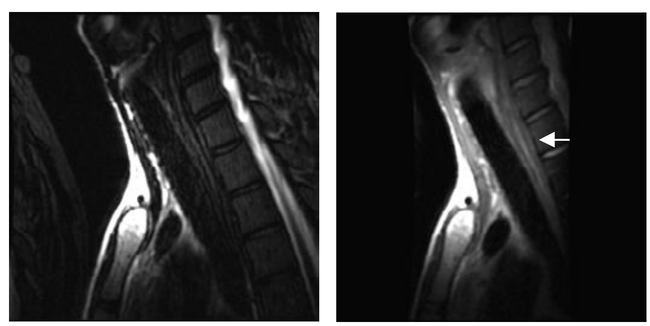

Fig. 3 Esophageal images. (Left) Conventional 3D FSE Image. (Right) 3D FSE image with inner volume and variable flip angle methods. An arrow indicates the wall layers.

Conclusion

Combination of the inner volume and variable flip angle methods enabled a T2 weighted imaging with high signal to noise ratio in 3D SSFSE. The wall layer structure of the esophagus could be recognized in these images, which will be useful for early diagnosis of esophageal cancer and the best selection of treatment options.

Acknowledgment

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References

1. Busse et al., MRM 55:1030-1037 (2006)
2. 2. Feinberg et al., Radiology 156:743-747 (1985).