

# Fast single-shot three-dimensional k-space acquisition (free factor) with balanced turbo field-echo imaging for visualization of the thoracic duct.

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## Introduction

Thoracic duct is a central lymphatic system and morphological highly variable [1]. It is important to know the course of the thoracic duct before surgery of the chest, because damage to the thoracic duct causes chylothorax after surgery, which sometimes results in serious problem for patients' management. Magnetic resonance thoracic ductography (MRTD) has been introduced using single-shot spin-echo sequence [2]. A major disadvantage of this technique is a relatively long acquisition time.

Single-shot three dimensional k-space acquisition (free factor) is fast sampling method with a single excitation obtaining larger than  $k_y$  or  $k_z$  without setting segmentation. The purpose of this study was to assess the visualization of the thoracic duct using 3D free factor with balanced turbo field-echo (bTFE).

## Subjects and Methods

Six healthy volunteers (age range, 26 – 44 years) of MRTD were scanned with 3D free factor with bTFE, 3D turbo spin-echo sequence (TSE), and conventional bTFE sequence at a 1.5T MRI unit (Achieva, Philips, The Netherlands). 32ch-torso-cardiac coil was used for scanning. Images were obtained under the respiratory gating. Cardiac gating was not set to reduce the scanning time. The parameters of these sequences are listed in Table 1. MRTD images were assessed by an experienced radiologist twice. We divided the thoracic duct into three segments (upper, middle, and lower). Each segment was assessed using a five-point scale; 0, no visualization; 1, partially visualization (partial visualized thoracic duct, but most of the thoracic duct is not visible), 2, moderately visualization (about half of the thoracic duct is visualized); 3, good visualization (partially impossible to identify the continuity of the thoracic duct); 4, completely visualized (no discontinuity of the thoracic duct). These scores were compared among three sequences

Table 1. Parameters of magnetic resonance thoracic ductography

Parameters	3D freefactor	Single-shot spin-echo	Conventional balanced field echo
TR/TE (ms)	4.6/2.3	4000/600	50/2.5
Flip angle (degree)	120	90	90
Turbo factor	200	89	143
Resolution (mm)	$1.47 \times 1.15 \times 1.60$	$1.22 \times 1.20 \times 1.60$	$1.57 \times 1.14 \times 1.60$
SENSE (P direction)	2	2	2
Fat suppression	no	SPIR	SPIR
Image	Real	Magnitude	Magnitude
Acquisition time	1min30-40sec	7min45-8min30sec	2min53sec-4min30sec

## Results

The median scores of free factor were 4 in all segments. The median score of TSE at the upper, middle, and lower segments was 2.0, 2.5, 4.0, respectively. The median score of conventional bTFE at the upper, middle, and lower segments was 2.0, 1.5, 2.0, respectively (Figure 1). Free factor showed good visualization in all segments among the sequences. Representative images are shown in Figures 2.

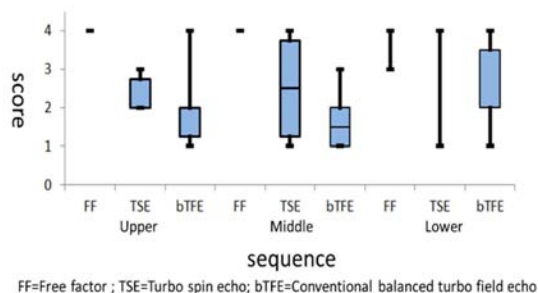


Figure 1.  
Graph shows the relationship of the score among three sequence according to the anatomical segment. Free factor shows good visualization in all segments.

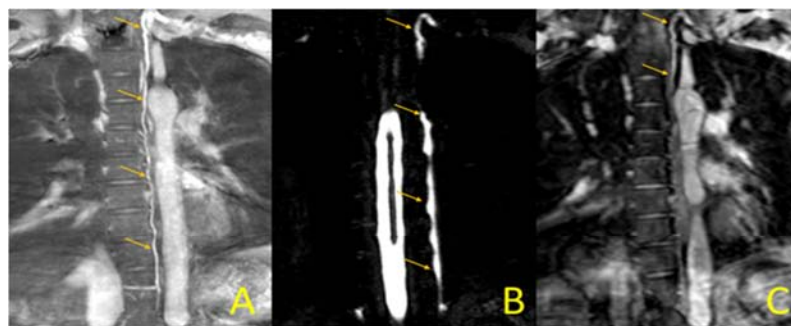


Figure 2.  
Images of a 29 years old man  
A, Free factor; B, Turbo spin-echo (TSE); C, Conventional balanced turbo field-echo (bTFE)  
Images of curved planar formation show the thoracic duct (Figures A-C, arrows). Free factor shows good visualization in all segments of the thoracic duct (Figure A, arrows). Partial poorly visualization is shown at the upper segment on TSE (Figure B), and at the middle and lower segment on bTFE (Figure C).

## Discussion and Conclusions

We found good visualization of the thoracic duct using 3D free factor with bTFE. This may attribute to single-shot short acquisition leading to a reduction of motion artifact from the heart and the arteries. The major advantage of free factor is a short acquisition time. Free factor also visualizes vessels because this sequence is based on balanced sequence. This fact is useful in grasp anatomical relation of the thoracic duct to the surrounding structures using multi-planar reformation, but is not suitable for maximum intensity projection (MIP); curved planar formation is suitable to grasp the entire course of the thoracic duct.

In conclusion, single-shot three dimensional k-space acquisition (free factor) with bTFE can be useful for the evaluation of the thoracic duct in a short acquisition time.

## References

- 1.Okuda, I., et al., Magnetic resonance-thoracic ductography: imaging aid for thoracic surgery and thoracic duct depiction based on embryological considerations. General Thoracic and Cardiovascular Surgery, 2009. 57(12): p. 640-646.
- 2.Okuda, I., et al., Depiction of the thoracic duct by magnetic resonance imaging: comparison between magnetic resonance imaging and the anatomical literature. Japanese Journal of Radiology, 2011. 29(1): p. 39-45.