

## Visualization and evaluation of esophageal peristalsis using TrueFISP cine MR imaging in patients with esophageal tumor

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**Introduction;** The esophagus has a contractility regulated by the autonomic nervous system. The contractile waves surge and convey ingested foods or fluid, and are called peristalses. Impaired motility of the esophagus can be caused by various etiologies encompassing esophageal tumor, achalasia or collagen disease such as progressive systemic sclerosis or dermatomyositis. Although 90 % of patients with esophageal cancer present with dysphagia as an initial symptom, the contribution of dysmotility to dysphagia is not fully discussed. To our knowledge, there has been no way to evaluate esophageal peristalsis directly at the time of contractile action. Recent advances in ultrafast MR imaging techniques, cine MR imaging has enabled direct visualization of kinematics in various organs. The utility of TrueFISP sequence has already been reported in demonstrating rapid movement such as swallowing or very subtle movement such as uterine peristalsis. The purpose of this study is to evaluate true FISP cine MRI in demonstrating the motility of the esophageal wall in patients with esophageal tumor, and to show advantages of evaluating peristalsis.

**Materials and methods;** This preliminary study was conducted in 13 patients with pathologically proven esophageal tumors (12 esophageal cancer and 1 submucosal leiomyoma). The cine-MRI was obtained after contrast-enhanced MR scan for the clinical purpose on a 1.5 T machine (Symphony, Siemens) with a phased-array body coil or head/neck coil. Cine MRI was performed using a TrueFISP sequence (TR 33-42ms, TE=1.5-2.1ms, Flip angle=70, FOV=250mm<sup>2</sup>, Matrix; 128, slice thickness =6.0). A total of 120 serial images were obtained within 60 seconds through either sagittal or oblique sagittal plane along the long axis of the esophagus. Before starting evaluation of peristalsis, cine MRI with same protocol was performed under natural breathing. Then patients were instructed to chew gum during cine MRI. When esophageal peristalsis was not recognizable, patients were required to swallow water (10-30 ml) from a plastic tube connected to a water cup. The serial TrueFISP images were displayed in cine mode at double to sixfold speed. The evaluated points on cine MRI included 1) presence of peristalsis, 2) presence of interruption of peristalsis, and 3) presence of passage through the tumor. The data analyzed from clinical images and cine mode images were compared with surgical and histologic findings (n=8), and clinical symptoms.

**Results;** The peristalsis was clearly identified in all patients. Complete interruption of peristalsis was noted in seven patients, which included four with occluded lumen without passage and three with intermittent passage caused by coordinated forcing movement of the proximal esophageal wall that alternatively inflated and deflated. Interruption of peristalsis was limited to the wall where tumor presented in two patients. In four patients, peristalsis surged over the tumors. All the seven patients with completely interrupted peristalsis had dysphagia. The three of four without passage had difficulties to intake liquid, while the remaining one and two of three patients with passage could intake liquid food. The remaining one presented only with discomfort. On the other hand, six patients with intact or partially impaired peristalsis had no problem to intake diet. In the comparison with surgical findings in eight patients, the three patients with complete interruption of peristalsis had circumferential esophageal cancer with massive invasion into the proper muscle layer. In two patients with partially impaired peristalsis, esophageal cancer did not exceed one-half of the circumferences, though the tumor invaded into the muscle layer. Three patients with intact peristalsis consisted of one with cancer confined to one side of the hypopharynx, one with a submucoal leiomyoma that did not involve the proper muscle, and one with a cancer that had only minimal microscopic invasion of the muscle layer.

**Discussion;** The presented study showed that cine-MR imaging using TrueFISP technique enabled direct visualization of peristalsis and tumor non-invasively. Compared with widely used conventional modality, cine MR offers several potential advantages in evaluation of esophageal motility. MR enables direct visualization of esophageal peristalsis with excellent soft tissue contrast. Tasks required to patients are minimal and safe. Finally, MR imaging is lack of ionizing radiation. Data from cine-MR showed good correlation with patient's clinical symptoms. Patients with interrupted peristalsis by esophageal tumors had difficulty in ingesting solid foods. Peristalsis seems essential in transition of solid foods. This relationship between the esophageal peristalsis and ability to ingest solid foods may explain the reason why the esophageal stent for advanced cancer does not always resolve dysphagia of patients. To be noted was that the presence of passage caused by forcing peristalsis well correlated with patients ability to intake liquid. Another point is that partial impairment of the esophageal peristalsis does not necessarily result in impairment of transition of food. Probably, the preservation of the esophageal motility may depend on what extent of the circumference was involved by the tumor. In our series, the impairment of the esophageal peristalsis seems closely correlated with impaired physiologic function of the muscles. Interruption of the esophageal peristalsis may be an indicator of circumferential involvement of the muscle layer by esophageal tumor, signifying T2 stage of esophageal cancer. Although this assessment has been obtained only with EUS, evaluation of the peristalsis on cine MR may be an alternative in certain clinical conditions where EUS was not available.

**Conclusion;** TrueFISP cine MR imaging enabled direct visualization of the esophageal motility with its relation to the esophageal tumors. An interruption of peristalsis and presence of intermittent passage well correlated with clinical symptoms and histologic characteristics of the tumors. Cine MR may become a new tool to evaluate esophageal motilities and disclose physiologic problems of the esophagus.