Accuracy of high-resolution MRI in the gastro-esophageal tract: a four-patient in vivo and ex vivo study.

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Purpose

Learning objectives

The aim of our study was to use high-resolution MRI in order to properly define the anatomical appearance and MR signal characteristics of the gastro-esophageal tract, as far as common and pathological findings in vivo and ex vivo are concerned.

The final purpose is to improve our imaging protocols in order to provide an accurate definition of the layers of the esophageal and gastric wall.

Background

Esophageal cancer is the eighth leading cause of malignancy and the sixth leading cause of death from cancer worldwide.\(^1,2\)

The majority of esophageal cancers are squamous cell carcinomas (SCC) or adenocarcinomas (AC). Although the incidence of SCC is decreasing, the incidence of AC is rising dramatically.

The prognosis for both types of cancer is poor. Five-year survival is 10 to 13 percent, although patients diagnosed with early stage may be cured by surgery, multimodality or endoscopic ablation therapy.\(^3\)

Gastric cancer remains one of the most common forms of cancer worldwide, with approximately 870,000 new cases and 650,000 deaths per year, accounting for about 9.9 percent of new cases.

The incidence of gastric cancer varies with different geographic regions. There is also substantial difference in the incidence among different ethnic groups within the same region. Surgically curable early gastric cancers are usually asymptomatic and only infrequently detected outside the realm of a screening program. Screening is not widely performed, except in countries which have a very high incidence, such as Japan, Venezuela and Chile.\(^4\)

The most critical aspect in patients with esophageal and gastric cancer is the accuracy of the clinical staging; the most accurate staging is fundamental for the best therapeutic outcome of the patient.

That is the reason why we carried out our study.
Recent advances in MRI technology have allowed its consolidation as pivotal imaging method in the staging of cervical, uterine and rectal cancers. 6,7,8

There are few data on literature concerning the employment of MRI in esophageal, GEJ and gastric cancers staging, probably due to perplexities regarding technical challenges that must be overcome such as the deep location of the viscera, cardiac, respiratory and peristaltic movements. These factors when associated with the inherent slow acquisition time of MRI results in decreased resolution of the images. However, many technical improvements such as breath-hold sequences and the use of antiperistaltic agents allow to obtain accurate images for the evaluation of the gastro-esophageal layers.
Methods and Materials

Imaging findings and procedure details

Formalin-fixed post-operative anatomical pieces of 4 patients (mean age: 64; 52 - 78 years) were investigated with a 1.5-T magnet (Achieva; Philips Medical Systems, Best, The Netherlands) with a phased-array surface knee coil positioned in according to tumor placement, using high-resolution T1 and T2-weighted sequences. Tumours were located in the esophagus (1), at the level of the gastro-esophageal junction (1) and in the stomach (2).

Esophageal and gastric specimens were distended with a solution of water and Lumirem® (Ferumoxsil) and set into plastic boxes.

The aspects of anatomical findings obtained on the ex vivo MR images were compared with their appearance on in vivo MR images and with the corresponding histopathological sections.

Magnetic Resonance protocol provided the following sequences:

T2W_TSE CLEAR axial: TR 2610, TE 100, thickness 3 mm, gap 0.1, FOV 149 (RL) 81 (AP) 40 (FH), acquisition matrix 360 x 318, reconstruction matrix 640.

T2W_TSE CLEAR coronal: TR 2610, TE 100, thickness 2.5 mm, gap 0.1, FOV 130 (FH) 74 (RL) 34 (AP), acquisition matrix 320 x 132, reconstruction matrix 640.

T1W_TSE CLEAR coronal: TR 450, TE 22, thickness 3.5 mm, gap 0.3, FOV 150 (RL) 65 (AP) 200 (FH), acquisition matrix 288 x 204, reconstruction matrix 400.
Results

Image analysis

The layers of the esophageal and gastric wall were clearly visible on high-resolution MRI, both in vivo and ex vivo images.

On T1-weighted images the inner layer (mucosa) was characterized by an increase of signal intensity; the second layer (submucosa) had a lower signal intensity while the third layer (muscularis propria - serosa) showed a higher signal intensity.

Normal mucosa T2-weighted appearance was characterized by a fine intermediate signal layer, surrounded by the high-signal intensity of submucosa and the low-signal-intensity of muscularis propria.

Altered anatomical MR appearance of tumours was documented as a subversion of the normal anatomical aspect of the wall layers.
Conclusion

Images obtained with high-resolution MRI before and after surgical resection are able to give precise anatomic information, increasing the accuracy in the detection of the invasion of gastro-esophageal wall layers and confirming the promising capability of MR as far as esophageal and gastric tumours are concerned.

High-resolution MRI can provide important information for planning surgical intervention as the depth of infiltration can be clearly defined.
References


5 TNM Staging, 7th edition


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