

PREOPERATIVE LOCAL STAGING WITH CONVENTIONAL MRI AND DWI-MRI IN CORRELATION WITH OTHERS PREOPERATIVE METHODICS AND WITH HISTOLOGICAL RESULTS CAN CHANGE SURGICAL TREATMENT IN GASTRIC CANCER?

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Abstract

Keywords:

Gastric cancer; preoperative staging; magnetic resonance imaging; diffusion weighted imaging

Purpose: To prospectively evaluate accuracy of diffusion-weighted-imaging (DWI) for preoperative staging of gastric cancer by using others preoperative methodics, surgical and histopathologic results as reference standards.

Materials and Methods: 87 patients with gastric adenocarcinoma, which underwent preoperative staging with 3 Tesla Magnetic Resonance Imaging (MRI), were enrolled. The radiologists evaluated the tumor staging in DWI. Results were compared to postsurgical pathologic findings.

Results: Conventional MRI has identified 69 cases and DWI was able to identify 81 cases of cancer (sensitivity of 80% and 93%). The T factor accuracy of conventional MRI and DWI was 73% and 82% respectively; while the N staging accuracy of conventional MRI and DWI was 79% and 93%, respectively.

Conclusion: DWI showed to be useful in preoperative staging of gastric cancer, in particular for the assessment of lymph nodes and peritoneal involvement. In fact DWI-MRI showed an improved diagnostic sensitivity compared to MRI standard protocol.

Introduction

Gastric carcinoma (GC) is one of the most common causes of cancer-related death worldwide. Surgical resection is the only cure available and it is dependent on the GC stage at presentation, which incorporates depth of tumor invasion, extent of lymph node and distant metastases. Accurate preoperative staging is therefore essential for optimal surgical management with consideration of preoperative and/or postoperative chemotherapy. Multidetector computed tomography (MDCT) with its ability to assess tumor depth, nodal disease and metastases is the preferred technique for staging GC. Endoscopic ultrasonography is more accurate for assessing the depth of wall invasion in early cancer, but is limited in the assessment of advanced local or stenotic cancer and detection of distant metastases. Magnetic resonance imaging (MRI), although useful for staging, is not proven to be effective. In particular MRI has never widely used for the staging of gastric cancer for its high costs, motion and respiration artifacts. Conventionally, the gastric cancer study consist of T1-weighted, T2-weighted, SPAIR, STIR sequences, and contrast-enhanced T1-weighted images; in the present study DWI sequencess have been used in addition to the standard protocol. Positron emission tomography (PET) is most useful for detecting and characterizing distant metastases. Both MDCT and PET are useful for assessment of treatment response following preoperative chemotherapy and for detection of recurrence after surgical resection. [1]

Currently, resection is the only curative option available for patients with gastric cancer [2,3,4] Accurate assessment of local tumor depth invasion (T), regional lymph node invasion (N), and distant metastases (M) is crucial to appropriate surgical and treatment planning [2,5]. Understaging of the disease may lead to positive resection margins or unnecessary laparotomy if metastases were not identified on pre-operative imaging. Overstaging a patient may lead to ineffective care if a potentially curative patient is incorrectly categorized as a palliative patient [6].

Surgery is the only potentially curative treatment of localized gastric carcinoma and radical gastrectomy with extended lymphadenectomy is now recognized as a reasonably safe procedure in experienced centers [7].

Materials and Methods

In our Surgery Department CROB Institute of Rionero in Vulture from January 2011 to October 2014 underwent surgery for gastric cancer 98 patients. Together with Radiology Department of our Institute, 87 patients with histologically confirmed gastric cancer were selected. Patients were 51 males and 36 females aged between 29 and 88 year, mean age of 67 year. All patients were subjected to endoscopy and MRI for preoperative staging. The interval between endoscopy and MRI was 4-7 days. Each patient was treated surgically 3-10 days after MRI. Considering all the 87 patients: 29 were subjected to total gastrectomy; 57 to subtotal gastrectomy; 1 patient has not been subjected to surgery because of disseminations and peritoneal ascites and so he wasn't considered in the study.

The surgery was performed for each patient a few days after the MRI pre-operative staging by exclusive surgeon oncologist with 20 years of experience in the field. Subsequently, the surgical findings were analyzed by the pathologist. The gastric carcinomas were staged by the pathologist according to the International Union Against Cancer classification [3]. Finally histopathological findings were compared with MRI and DWI-MRI data.

Results

T Staging

In the 86 patients with gastric cancer that underwent surgery, conventional MRI has identified 69 cases of cancer while DWI-MRI was able to identify 81 cases of cancer, with a diagnostic accuracy of 80% and 93%, respectively (table 1). The preoperative DWI has identified the carcinomatous area in patients with a stage more advanced than T1: pathological parietal thickening greater than 1 cm with signs of marginal irregularities was identified. These tumor lesions showed increased signal intensity in DWI images with b0, b350, b750 values and a reduction of the signal in ADC maps (figure 1). The average ADC value was 0.811 ± 0.30 mm²/s compared to normal gastric walls which showed an average ADC value of 1.503 ± 0.43 mm²/s. Considering the T staging conventional MRI identified 8 T1, 11 T2, 14 T3 and 28 T4, while DWI MRI evaluated 10 T1, 13 T2, 17 T3 and 31 T4 (table 2). The histological evaluation is as follows: 18 T1, 15 T2, 20 T3 and 33 T4. Conventional MRI and MRI-DWI were able to locate the area of pathological tissue in the patient with early gastric cancer only in 8 and 10 cases of T1 respectively. Conventional MRI was not able to locate 4 cases of T2, 6 cases of T3 and 5 cases of T4. Two cases of T2, instead, was understaged by DWI and 3 of T3 and 2 cases of T4 has been understaged to T2 and T3. The accuracy of conventional MRI and MRI-DWI in determining the T factor, according to the TNM classification, were 73% and 82% respectively (table 2).

N Staging

In the analysis of the N factor we have considered the lymph nodes according to the Japanese Classification of Gastric Carcinoma from Japanese Gastric Cancer Association. Lymph nodes identified in MRI had minimum transverse diameter greater than 8 mm, of oval appearance, restriction pathological signal in DWI and low ADC value (1.70 ± 0.40 mm²/s) compared to non-metastatic lymph nodes (2.10 ± 0.22), with high signal intensity and similar to that of the primary tumor in the high b values images. Using conventional MRI we found 12 cases of N0, 15 cases of N1, 6 case of N2 and 35 cases of N3. Employing MRI-DWI we found 24 cases of N0, 12 cases of N1, 12 case of N2 and 32 cases of N3 (table 5). Histologically we found 25 cases of N0, 11 cases of N1, 15 cases of N2 and 35 cases of N3. Finally conventional MRI understaged 13 cases of N0 and 9 cases of N2 but overstaged 4 N1; MRI-DWI instead overstaged a case of N1 and understaged 1 N0, 3 N2 and 3 N3. The accuracy of conventional MRI and DWI-MRI in N staging was 79% and 93%, respectively.

M staging

The conventional MRI identified neoplastic invasion of the serosa of the greater omentum, with contextual lymph node masses and peritoneum invasion in 1 on 1 case. The same result was obtained with the DWI scans. This pre-operative method identified a pathological restriction of the signal and therefore neoplastic invasion of the serosa of the greater omentum, with contextual lymph node masses, peritoneum invasion and ascites. In presence of peritoneal metastases, using DWI, ascites and intestinal contents are suppressed, while solid tumors and peritoneal serous show a more limited dissemination and they are visible as linear areas or focal masses of high signal intensity. However it was not possible to compare MRI images to histology results because the patient has not been treated surgically.

	CONVENTIONAL MRI	DWI-MRI
Diagnosed Cases	69	81
Diagnostic Sensitivity	80%	93%

Table 1. Diagnostic sensitivity in conventional MRI and in DWI-MRI

T staging	CONVENTIONAL MRI	DWI-MRI
Accuracy	73%	82%

Table 2. T staging accuracy in conventional MRI and in DWI-MRI

	T1	T2	T3	T4
Conventional MRI	8	11	14	28
MRI-DWI	10	13	17	31
Histology	18	15	20	33

Table 3. T staging results: comparison between histology, MRI and DWI.

N staging	CONVENTIONAL MRI	DWI-MRI
Accuracy	79%	93%

Table 4. N staging accuracy in conventional MRI and in DWI-MRI

	N0	N1	N2	N3
Conventional-MRI	12	15	6	35
MRI-DWI	24	12	12	32
Histology	25	11	15	35

Table 5. N staging results: comparison between histology, MRI and DWI.

Discussion

Gastric cancer is characterized by extreme loco-regional aggressiveness. The partial or total gastrectomy, combined with chemotherapy or radiotherapy, is the only effective therapeutic option which, if implemented at an early stage of the disease, may result in an improved survival in selected groups of patients[5]. Gastric cancer diagnosis is usually endoscopic; the staging is the next step, that will guide the therapy. The Endosonography has always been considered the most accurate method for the T staging of gastric cancer. This method, however, is not able to assess the invasion of lymph nodes and liver and peritoneal metastases [9,10]. CT is widely used in the staging of gastric cancer because its characteristics allow the assessment of gastric wall, lymph node and peritoneal invasion and adjacent organs metastasis with signs of peritoneal carcinomatosis [10]. The sensitivity is 88% in the diagnosis (with problems related to poor gastric distension) and 68% for the N-staging. The accuracy in T-staging is 60% [8]. The PET is widely used in oncology especially in the evaluation of the M parameter but it has been poorly tested in the study of gastric carcinoma. MRI has not been widely used in the staging of gastric cancer, mainly due to the presence of artifacts related to movement. Anyway, in the recent years, the use of fast and breath-hold scans, the administration of antiperistaltic drugs and the introduction of specific contrast medium have improved image quality and reduced artifacts. Some authors have demonstrated that MRI has an accuracy not significantly different from CT in the T and N staging. MRI showed the same limitations than CT in the N-staging as there is no specific criterion in the determination of the lymphadenopathy [9]. There are few papers regarding the diagnostic accuracy of MRI, and

in particular the role of DWI, in the identification and staging of gastric cancer [8,10]. In particular, in advanced stages, MRI sensitivity is high in the detection of liver metastases but the definition of peritoneal carcinomatosis reveals difficult due to motion artifacts and breathing and concluded that the DWI is very sensitive in advanced gastric carcinomas but less reliable than gastroscopy for the diagnosis of early gastric cancer. In our study we used DWI sequences in addition to the standard MRI protocol and we showed that 3T DWI-MRI, with an optimized protocol for the study of gastric pathology, allows to diagnose the tumor even in the T2 stage and to predict the surgical resectability accurately. High field strength allows to better evaluate the different layers of the gastric wall. In the analysis of the T factor (table 2) we found, in agreement with other studies [11], high diagnostic accuracy in identifying tumors higher than T1 stage. In fact, analysis of the T factor was rather disappointing in the early stages T0-T2, compared to gastroscopy, as demonstrated by the case of early gastric cancer (pT1) that has not been identified by the DWI. The cause, probably, has been the difficulty of the distension of the stomach wall in some poorly cooperative patients and therefore a greater difficulty in the identification of the layers. It is therefore difficult to differentiate between pT1 and pT2; much more accurate is the assessment of the extent extra-serosa (pT3) and the invasion of the surrounding structures (pT4). In our analysis of the N factor, we found that MRI-DWI showed high diagnostic accuracy compared to conventional MRI. The evaluation of metastatic lymph nodes, on the basis of size criterion or based on signal changes in MRI, as a malignancy index, has always shown the limits both in MRI and CT. The DWI-MRI, based on its principles of restriction pathological signal related to cellularity, added more information compared to the images obtained with the standard protocol, improving the diagnostic accuracy of MRI in the evaluation of lymph node metastases. In fact, in our patient population, in agreement with other studies [12], we found a high signal intensity of the suspicious lymph nodes. Pathological lymph nodes also showed a DWI signal intensity comparable to the tumor (figure 2). Our study confirms like other [13] that: the limitations of conventional MRI, concerning gastric cancer, can be overcome by associating DWI scans to the standard MRI protocol. In fact DWI makes it easier to assess mesenteric metastases, small intestine and peritoneal layers that surrounding liver and pancreas. DWI images are more easily interpretable if associated to those of conventional MRI that improve the anatomical identification of these injuries. The DWI increased contrast of peritoneal tumor simplifies the ability to interpret the image and improves the visibility of the lesion. The limit of DWI in our study, as well as in other studies [14] was the poor anatomical resolution. This limit is surmountable combining DWI with conventional MRI, in particular using STIR sequences that improve the anatomical resolution and therefore the identification of peritoneal lesions. Another difficulty has been the small size of the nodules in the peritoneal carcinomatosis with consequent difficulty in setting the ROI for the ADC calculation. Compared to a previous study that concerned a small sample size, in this study we established so, with a larger population study, confirmation our results [15] but did not change our surgical strategy because its low rate to identify the Gastric Cancer in its early stage. Only in this case surgery in fact may be different from standard gastrectomy with D2 lymphadenectomy.

Conclusions

In our study DWI-MRI is more accurate in evaluation of T stage than Conventional-MRI 82% vs 73% and N stage 93% vs 79% and is superior in identifying early stages of gastric cancer so can be considered a valid alternative to MDCT in clinical practice too.

In the literature, we found that the various methods represent a valuable diagnostic aid in the care and treatment of tumors of the stomach. The data relating to work done by colleagues radiologists we realize how the accuracy and sensitivity of DWI-MRI compared to conventional MRI is superior in terms of percentages also compared to other methods. This data allows us to have pictures and more detailed information on high-definition stage of the cancer, but in most cases did not change our surgery strategy and the gold standard were surgery and histopathological findings.

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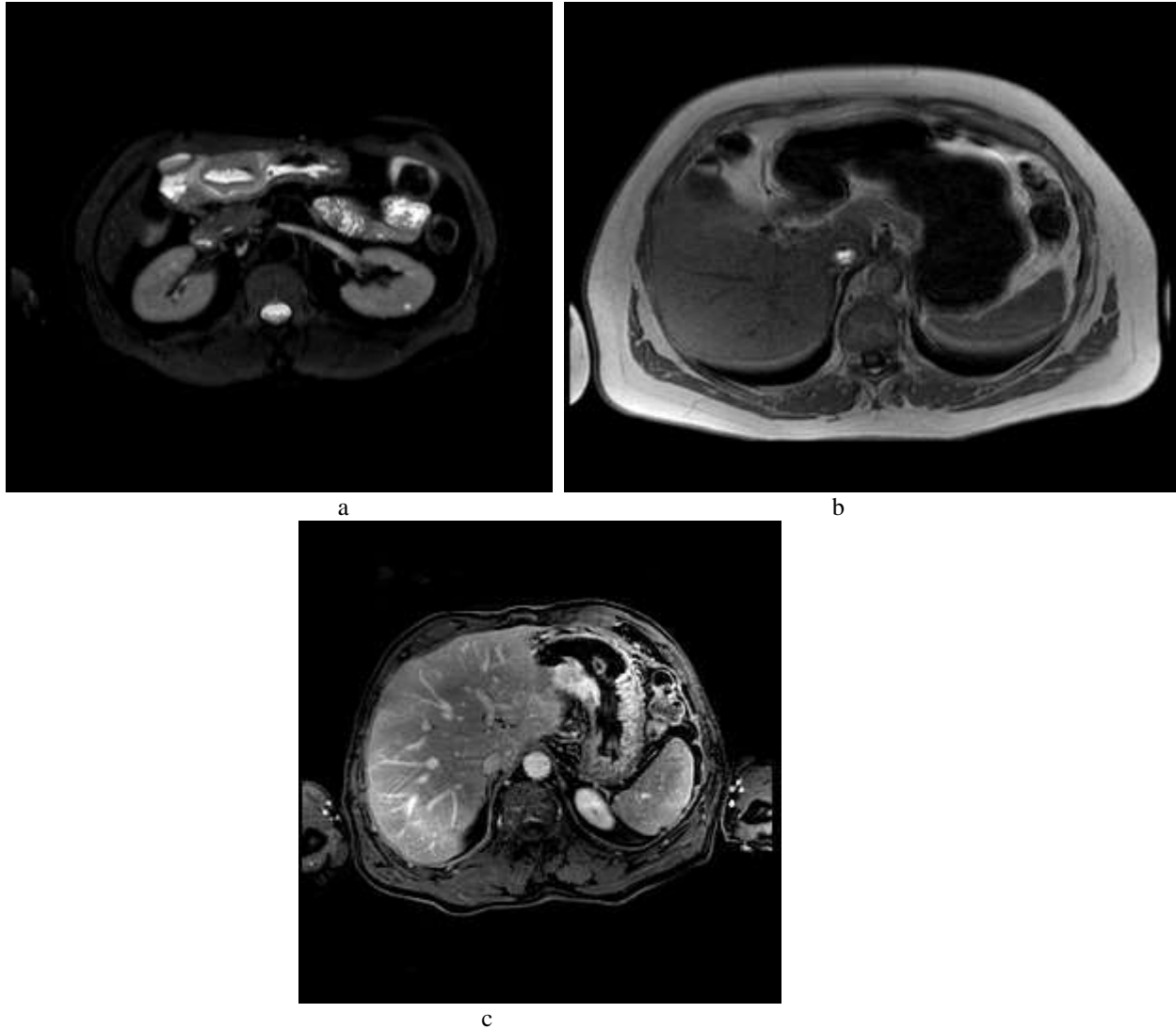


Figure 1. Different T stage : a) Circumferential thickening of the gastric walls in antral-pyloric region without trespassing beyond the serosa T2 – b) Parietal lesion crater of up to 4 cm to angulus-pyloric. Perilesional lymph nodes T3 c) Thickening of the gastric wall in antral-pyloric region with trespassing to the pancreas as well as to create a pseudo-mass with the weary cellular. A few subcentimeter lymph node to lesser curvature T4 -

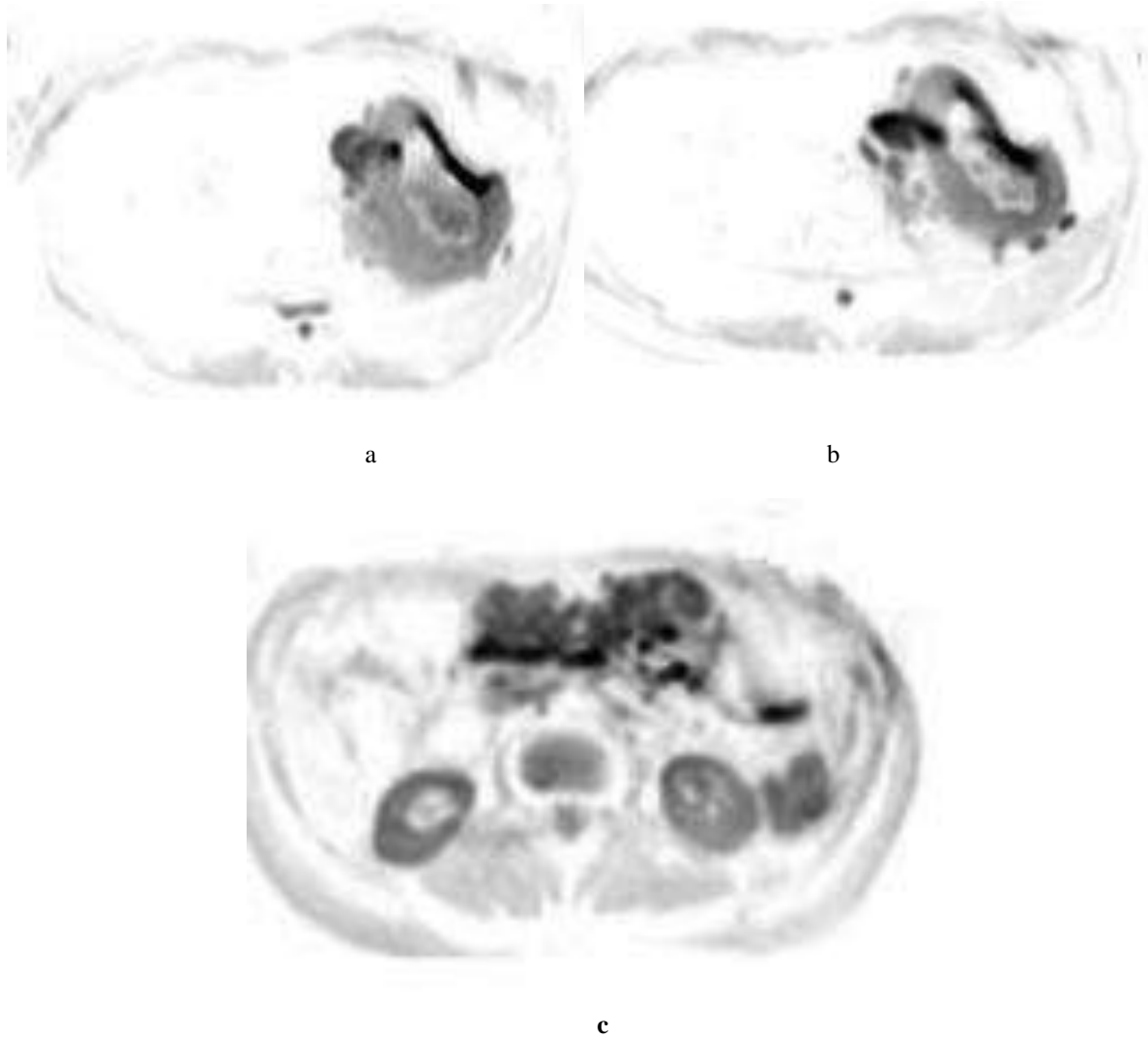


Figure 2. Different N stage : a) N1 axial reversed DWI image showing a single lymph node pathological signal restriction in the perigastric area; b) N2 axial reversed DWI image showing four regional lymph nodes; c) N3 axial reversed DWI image showing more than seven pathological lymph nodes.