

# Accuracy of Whole-Body Diffusion-Weighted MRI (WB-DWI/MRI) in Diagnosis, Staging and Follow-Up of Gastric Cancer, in Comparison to CT: A Pilot Study.

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## Research article

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# Abstract

**Background:** Accurate staging of patients with gastric cancer is necessary for selection of the most appropriate and personalized therapy. Computed Tomography (CT) is currently used as primary staging tool, being widely available with a relatively high accuracy for the detection of parenchymal metastases, but with low sensitivity for the detection of peritoneal metastases. Magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI) has a very high spatial and contrast resolution, suggesting a higher diagnostic performance in the detection of small peritoneal lesions. The aim of this study was to retrospectively evaluate the added value of whole-body diffusion-weighted MRI (WB-DWI/MRI) to CT for detection of peritoneal carcinomatosis (PC) and distant metastases in the preoperative staging of gastric cancer.

**Methods:** This retrospective study included thirty-two patients with a suspicion of gastric cancer/recurrence, who underwent WB-DWI/MRI at 1.5 Tesla, in addition to CT of thorax and abdomen. Images were evaluated by two experienced abdominal radiologists in consensus. Histopathology, laparoscopy and/or 1-year follow-up were used as reference standard.

**Results:** For overall tumor detection ( $n=32$ ), CT sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) was 83.3%, 100%, 100% and 82.4% respectively. For WB-DWI/MRI these values were 100%, 92.9%, 94.7% and 100%, respectively. For staging ( $n=18$ ) malignant lymph nodes and metastases, CT had a sensitivity, specificity/ PPV/ NPV of 50%/ 100%/ 100%/ 71.4%, and 15.4%/ 100%/ 100%/ 31.3% respectively. For WB-DWI/MRI, all values were 100%, for both malignant lymph nodes and metastases.

WB-DWI/MRI was significantly better than CT in detecting tumor infiltration of the mesenteric root, serosal involvement of the small bowel and peritoneal metastases for which WB-DWI/MRI was correct in 100% of these cases, CT 0%.

**Conclusions:** WB-DWI/MRI is highly accurate for diagnosis, staging and follow-up of patients with suspected gastric cancer. These results need to be confirmed in larger studies.

## Background

Gastric cancer remains one of the deadliest neoplasms in the world, with a 5-year survival rate of approximately 25% for all stages [1, 2]. Once spread to the peritoneum, the 5-year survival rate drops to less than 5% [3]. Up to 40% of gastric cancer patients develop some degree of peritoneal metastases during the course of their disease [3]. After gastric cancer resection, hematogenous recurrence is most common (54%), with peritoneal disease being the second most common site of recurrence, accountable for around 43 to 45.9% [4, 5]. Other common sites of recurrence are lymph nodes (12%) and locoregional in 22% [4]. Accurate staging of all tumor locations is essential in these gastric cancer patients to select the best treatment with the highest chance of cure. As these patients have a high risk of peritoneal dissemination, an imaging technique that can detect small volume disease is needed.

According to ESMO Guidelines, outlined by Lerut et al [6], local staging with gastroscopy and Endoscopic Ultrasound (EU) should be combined with distant staging by a CT scan of the thorax and abdomen to detect metastases elsewhere in the body [6–8]. Sensitivity of CT for the evaluation of lymph node metastases is variable (62.5%-91.9%) [9], due to the lack of standard criteria for diagnosing metastatic lymph nodes [10]. Size is the most commonly used criterion to define whether or not a lymph node is metastatic. However, short-axis cut-off levels to define a metastatic lymph node vary between different studies from > 5 mm to > 10 mm. Furthermore, large lymph nodes may be inflammatory and small lymph nodes may harbor millimetric tumor metastases [11]. The accuracy of CT in detecting metastatic disease to liver and lung, according to Seevaratnam [12] is high (81%). However, a recent review of four studies revealed rather low and variable sensitivities (14.3–59.1%), with high specificities (93.3–99.8%) [13], questioning its standard use in clinical practice. Moreover, CT estimation of peritoneal cancer spread is far from optimal with a sensitivity of only 28.3% (although with a high specificity of 98.9%) [14], due to its limited soft tissue contrast resolution [15, 16].

Limitations of  $^{18}\text{F}$ -Fluoro-deoxyglucose positron emission tomography (FDG-PET/CT) are not only in the assessment of (small) lymph node involvement [17, 18], but also and especially in the estimation of peritoneal cancer spread, most profoundly in small volume disease [19, 20]. Therefore, both CT and PET/CT are not ideal for accurate staging and treatment planning [21].

Diagnostic laparoscopy is recommended for all stage IB-III, potentially resectable gastric cancer patients to exclude (PET/)CT-graphically occult metastatic disease [6–8]. A review of 15 studies reported a variable high laparoscopic sensitivity ranging from 64.3–94% [22] for the detection of peritoneal metastases, which is higher than in CT. However, laparoscopy remains an invasive surgical procedure and only provides information about structures in the peritoneal cavity. Diffusion-weighted magnetic resonance imaging (DWI/MRI) may act as a problem solver in this situation. In DWI, contrast is generated between tissues due to differences in water proton mobility. In highly cellular tissues such as tumors, water diffusion is restricted, resulting in higher signal intensity on DWI with high *b* values and lower apparent diffusion coefficients (ADC), compared to the normal surrounding tissue, where water molecules can move freely. Due to the high contrast resolution in DWI tumor depiction can significantly be improved, particularly for peritoneal disease [23, 24]. DWI/MRI can be used as a whole body (WB) imaging technique, for evaluation of primary tumor, lymph nodes and metastases in one single, noninvasive examination [25–28]. The aim of this study was to retrospectively evaluate the added value of whole-body diffusion-weighted MRI (WB-DWI/MRI) to CT for detection of peritoneal carcinomatosis (PC) and distant metastases in the preoperative staging of gastric cancer.

## Methods

### Patients

This retrospective study was approved by the institutional review board (Ethical Committee Imelda Hospital Bonheiden). Informed consent was waived. Between November 2015 and April 2019, 32

consecutive patients with suspected primary or recurrent gastric cancer underwent a WB-DWI/MRI, for diagnosis and/or assessment of operability. They all underwent a CT of the thorax and abdomen within 20 days of the MRI.

### **Computed tomography**

Patients received oral contrast (30 ml iodinated contrast agent (Telebrix Gastro, Guerbet), 300 mg/ml, in 900 ml water), during 1 hour prior to a breath-hold CT scan of the thorax and abdomen (Somatom Force, Siemens Medical Systems, Erlangen, Germany). Images were obtained approximately 70s following intravenous iodinated contrast injection (80ml, Xenetix, Guerbet), which is the optimal timing for evaluation of the gastric tumor as well as possible hepatic metastases [10]. Images were acquired in the axial plane, and reconstructed in coronal and sagittal planes (2mm).

The following parameters were used: pitch 0.6, rotation speed 0.5 sec, 1 mm slice thickness, 0 mm slice gap and 0.6 mm collimation. A reference current of 81 mAs (thorax) and 110 mAs (abdomen) was used with automated Care Dose software.

### **WB-DWI/MRI (table 1)**

Patient preparation consisted of drinking one liter of pineapple juice during two hours prior to the examination, to minimize the high signal intensities of the bowel content on the diffusion-weighted images. Antispasmodic medication (butylhyoscine, 20 mg IV) was injected at the start of the examination to decrease bowel movement. All WB-DWI/MRI examinations were performed on a 1.5 Tesla scanner (Aera, Siemens Medical Systems, Erlangen, Germany) with multichannel phased-array surface coils and parallel imaging techniques. Diffusion-weighted images were acquired in the axial plane, free-breathing in four imaging stations (head/neck, thorax, abdomen and pelvis) at  $b=50$  and  $b=1000$  s/mm<sup>2</sup> ( $b1000$ ), and reconstructed in the coronal plane from head to femora. Free-breathing coronal single-shot fast spin-echo T2-weighted images were acquired in the four imaging stations. Breath-hold fat-suppressed T1-weighted gradient-echo sequences after the injection of Gadolinium (Dotarem, Guerbet, Roissy, France) were acquired in the axial plane in the four imaging stations and in the coronal plane for the abdomen and pelvis.

### **Evaluation of imaging**

All 32 patients underwent both CT and WB-DWI/MRI. CT and WB-DWI/MRI-examinations were read by two abdominal radiologists (13 years and 20 years of experience in oncological imaging) in consensus, for identification of the primary tumor, possible lymphadenopathies, peritoneal and/or distant metastases. The images were read in a random order, with a time interval of two months between the interpretation of the CT and the MRI. The readers were blinded to the results of the other imaging technique, patient history, surgical and pathological outcome.

At CT, the following criteria were used for metastatic lymph nodes: short axis diameter of >6 mm, roundness, heterogeneous contrast-enhancement and/or central necrosis. Peritoneal metastases were diagnosed in the presence of nodules on the peritoneal surface, mesentery and/or bowel wall, and/or irregular peritoneal and/or serosal thickening with enhancement. In the presence of ascites, irrespective of nodular peritoneal thickening, a suspicion for peritoneal implants was made. Distant metastases were diagnosed in the presence of malignant lesions in the liver, lungs, bones and/or other organs.

At WB-DWI/MRI, the information of *b*1000 diffusion-weighted images and anatomical sequences were combined. Lymph nodes with markedly higher *b*1000 signal intensity than the surrounding lymph nodes in combination with round and/or irregular shape and heterogeneous signal on T2 and/or post contrast images, were considered to be malignant. For diagnosing peritoneal and distant metastases the same anatomical criteria were used as in CT, in combination with contrast enhancement and/or high signal at *b*1000 images, not caused by T2 shine through.

For the selection of the operability of the patients, ESMO guidelines were used. Patients were considered operable in the absence of inaccessible lymph nodes, distant mesenteric, distant peritoneal and/or parenchymal metastases.

## Statistical analysis

Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of CT and WB-DWI/MRI were calculated for overall tumor detection, staging of malignant lymph nodes and metastases as well as operability assessment. Reference standard for CT and MRI was histopathology, laparoscopy and/or imaging follow-up for at least 1 year. Comparison of CT and MR accuracies was performed using McNemar's tests, with a p-value 0.05 indicating a statistically significant difference.

# Results

## Patient and tumor characteristics (table 2)

The study population consisted of 22 men and 10 women, with an age range of 29-85 years. Eighteen patients were diagnosed with gastric cancer (primary cancers  $n=15$ , recurrences  $n=3$ ), all were histopathologically confirmed (adenocarcinoma  $n=9$ , adenocarcinoma with signet ring cell differentiation  $n=9$ ). Two patients had gastritis, 12 had a history of gastric cancer with negative follow-up examinations.

## Tumor detection

Of the 15 primary cancers and 3 recurrences, WB-DWI/MRI correctly detected tumor in all these 18 patients. CT was only able to detect 15 of the 18 patients with tumor.

Twelve patients had a history of gastrectomy. CT as well as WB-DWI/MRI showed no disease recurrence. This was confirmed by a negative follow-up for at least 1 year.

Two patients had histopathologically confirmed gastritis. Of these, MRI was correct in 1 patient and wrongly diagnosed 1 patient as having operable gastric cancer. In both patients, CT was negative for tumor presence.

For tumor detection, WB-DWI/MRI had a sensitivity of 100%, specificity of 92.9%, PPV of 94.7% and NPV of 100% (18 TP, 13 TN, 1 FP and 0 FN). The numbers for CT were: 83.3%, 100%, 100% and 82.4% (15 TP, 14 TN, 0 FP and 3 FN), respectively. No significant difference in accuracy was found between WB-DWI/MRI and CT (96.9% vs 90.6%,  $p=0.32$ ).

## **Staging of patients with tumor (n=18)**

### ***Lymph nodes***

Eight patients were diagnosed with adenopathies (locoregional n=5, retroperitoneal n=2, paracardial n=1), 10 without. WB-DWI/MRI was correct in all patients, CT missed lymphadenopathies in 4 patients (locoregional n=3 and paracardial n=1) but correctly interpreted the other patients (sensitivity 50%, specificity 100%, PPV 100%, NPV 71.4%). WB-DWI/MRI accuracy was significantly higher than CT (100% vs 77.8%,  $p=0.046$ ).

### ***Distant metastases***

Thirteen patients were diagnosed with (a combination of different) distant metastases (peritoneal n=13, bone n=2, brain n=1), 5 without. WB-DWI/MRI correctly interpreted all patients (sensitivity, specificity, PPV and NPV 100%). CT suggested possible peritoneal tumor implants in 2 patients, and failed to identify peritoneal metastases in 11 patients and as well as bone metastases in 2 patients (on a per-patient basis: sensitivity 15.4%, specificity 100%, PPV 100%, NPV 31.3% (2 TP, 5 TN, 0 FP, 11 FN), where WB-DWI/MRI was correct. Since the brain is included in the whole body DWI/MRI, 1 patient with brain metastases was detected. Accuracy on WB-DWI was significantly higher than on CT (100% vs 38.9%,  $p<0.001$ ).

## **Operability assessment**

Of the 18 patients with tumor, 10 patients turned out to be inoperable and 8 patients were operable. All three recurrences were inoperable. Two of them had peritoneal (serosal) metastases, not visible on CT, with secondary small bowel obstruction. The third patient had inaccessible retroperitoneal lymph nodes diagnosed on CT, but also peritoneal implants missed by CT.

Of the 15 primary cancers, 7 were inoperable. In 2 patients, CT suggested inoperability due to distant lymph nodes (n=2), and hydronephrosis due to possible tumoral obstruction of the distal ureter (n=1). The other 5 patients seemed operable on CT. However, they were all clearly inoperable at WB-DWI/MRI due to peritoneal metastases (n=7), brain metastases (n=1) and bone metastases (n=2). In 6 patients metastases were confirmed during follow-up imaging; in 1 patient peritoneal metastases were confirmed by histopathology during laparoscopy.

The other 8 patients were able to undergo curative surgery. These patients all seemed primarily operable on CT and WB-DWI/MRI. The added value of WB-DWI/MRI was in the detection of the primary tumor (n=3) and better delineation of the extent of the tumor (n=3). In three patients (3/8; 37.5%), WB-DWI/MRI revealed small peritoneal tumor implants on the surface of the pancreas, which were not detected by laparoscopy, though histopathologically confirmed after surgery.

Overall, the numbers for prediction of inoperability for CT were: sensitivity of 30%, specificity 100%, PPV 100% and NPV 53.3%. For WB-DWI/MRI all these values were 100%, leading to an accuracy that was significantly higher than CT (100% vs 61.1%,  $p=0.008$ ).

## Discussion

Patients with gastric cancer/recurrence benefit from accurate diagnosis, staging and follow-up, maximizing the chance of complete resection and improved survival. The present study showed a high accuracy of WB-DWI/MRI of 96.9% for tumor detection, with only one false positive result, where a patient with gastritis was falsely interpreted as a small operable gastric cancer. Furthermore, WB-DWI/MRI was highly accurate for the prediction of inoperability (PPV 100%, NPV 100%), compared to CT (PPV 100%, NPV 53.3%). In 3 patients, WB-DWI/MRI revealed small peritoneal tumor-implants on the surface of the pancreas, not detectable with laparoscopy, suggesting higher sensitivity of WB-DWI/MRI over laparoscopy.

According to recent literature [29–32], the role of MRI in gastric cancer imaging has become more important with DWI and the calculation of ADC as a possible biomarker in diagnosis, T-staging and treatment response assessment [29]. Little is written about the role of MRI in determining metastatic gastric cancer [32]. Some studies suggest that the diagnostic performance of (DWI-)/MRI [33, 34] does not significantly differ from  $^{18}\text{F}$ -FDG PET/CT or CT. However, these studies contained few patients with peritoneal disease (3/49 gastric cancers) [33] and only one gastric adenocarcinoma (out of 30 different gastrointestinal malignancies) [34]. Moreover, both studies used different bowel preparation as well as different  $b$  values [33, 34].

Other studies involving tumors with different histopathology (mainly ovarian and colorectal) [15, 23, 28] showed that CT had an insufficient performance to detect PC with accuracies around 51–88%, being even higher than in our study with an accuracy of CT of 38.9%. CT especially fails in detecting tumor infiltration of the mesenteric root and serosal involvement of the small bowel with an accuracy in our study of 0%, compared to other studies where accuracies ranged from 21 to 48% [15, 23, 28, 35, 36]. DWI/MRI is known to be very good at detecting peritoneal tumor implants and implants at the small bowel wall with accuracies of 92–95% [23, 28], which is completely in line with our study (100%).

A limitation of this study is the small study population, presenting both primary and recurrent tumors. However, to our knowledge this is the first study to describe the role of WB-DWI/MRI in gastric cancer, with the confirmation that it also works on 1.5T and not only 3T.

## Conclusion

With the results of this pilot study we can conclude that WB-DWI/MRI is a powerful one-stop imaging method in staging gastric cancer, providing all needed information about disease extent and disease location, inside and outside the abdominal cavity, to successfully determine operability. These results need to be confirmed in larger studies.

## List Of Abbreviations

CT: Computed Tomography

MRI: Magnetic Resonance Imaging

DWI: Diffusion-weighted Imaging

WB-DWI/MRI: whole-body diffusion-weighted MRI

PC: Peritoneal carcinomatosis

FDG-PET/CT: <sup>18</sup>F-Fluoro-deoxyglucose positron emission tomography

ADC: apparent diffusion coefficient

## Declarations

### Ethical Approval and Consent to participate

This retrospective study was approved by the institutional review board (Ethical Committee Imelda Hospital Bonheiden, 10/12/2019, committee's reference number 191248). Informed consent was waived.

### Consent for publication

Not applicable.

### Availability of supporting data

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

### Funding

Not applicable

## Author's contributions

Study concepts: SDV, VV, FDK, RD. Study design: SDV, VV, FDK, RD. Data acquisition: SDV, VV, YDB, SC, KV, TT, RD. Quality control of data: SDV, VV, YDB, RD. Data analysis and interpretation: SDV, VV, YDB, RD. Statistical analysis: SDV, FDK, RD. Manuscript preparation: SDV, FDK, RD. Manuscript editing and reviewing: all authors. All authors read and approved the final manuscript.

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## References

1. Bray F, Ferlay J, Soerjomataram I, et al. Global Cancer statistics 2018: GLOBOCAN estimates of incidence of mortality worldwide for 36 cancers in 185 countries. *CA Cancer J CLIN* 2018; 394-424.
2. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics, *CA Cancer J Clin*. 2011; 61; 69-90
3. Sarela AI, Miner TJ, Karpeh MS, Coit DG, Jaques DP, Brennan MF. Clinical Outcomes with laparoscopic stage M1, unresected gastric adenocarcinoma. *Ann Surg* 2006; 243:189-195.
4. Maehara Y, Hasuda S, Koga T, Tokunaga E, Kakeji Y, Sugimachi K. Postoperative outcome and sites of recurrence in patients following curative resection of gastric cancer. *Br J Surg*. 2000 Mar; 87(3): 353-7.
5. Yoo CH, Noh SH, Shin DW et al. Recurrence following curative resection for gastric carcinoma. *Br J Surg* 2000; 87: 236-242.
6. Lerut T, Stordeur S, Verleye L et al. Clinical Practice Guidelines: Upper Gastrointestinal Cancer – update. Report 179A. Brussels, Belgium: Belgian Health Care Knowledge Centre; 2012.
7. Smyth EC, Verheij M, Allum W, Cunningham D, Cervantes A, Arnold D, on behalf of the ESMO Guidelines Committee. *Annales of Oncology* 27 (Supplement 5): v38-v49, 2016
8. Coburn N, Cosby R, Klein L, Knight, Malthaner R, Mamazza J, Mercer CD, Ringash J. Staging and surgical approaches in gastric cancer: a clinical practice guideline. *Curr Oncol*. 2017 Oct; 24(5):324-331.
9. Kwee RM, Kwee TC. Imaging in assessing lymph node status in gastric cancer. *Gastric Cancer* 2009; 12:6-22.

10. Choi JI, Joo I, Lee JM. State of the art preoperative staging of gastric cancer by MDCT and magnetic resonance imaging. *World J Gastroenterol* 2014 April 28; 20(16): 4546-4557.
11. Borggreve AS, Goense L, Brenkman H, Mook S, Meijer G, Wessels F, Verheij M, Jansen E, Van Hillegersberg R, Van Rossum P, Ruurda J. Imaging strategies in the management of gastric cancer: current role and future potential of MRI. *Br J Radiol* 2019; 92: 20181044.
12. Seevaratnam R, Cardoso R, McGregor C et al. How useful is preoperative imaging for tumor, node, metastasis (TNM) staging of gastric cancer? A meta-analysis. *Gastric Cancer* 2012; 15(suppl 1): S3-18.
13. Kwee RM, Kwee TC. Modern imaging techniques for preoperative detection of distant metastases in gastric cancer. *World J Gastroenterol* 2015; 21: 10502-9.
14. Kim SJ, Kim H-H, Kim YH, Hwang SH, Lee HS, Park DJ, et al. Peritoneal metastasis: detection with 16- or 64-detector row CT in patients undergoing surgery for gastric cancer. *Radiology* 2009; 253: 407-15.
15. Koh JL, Yan TD, Glenn D, Morris DL. Evaluation of preoperative computed tomography in estimating peritoneal cancer index in colorectal peritoneal carcinomatosis. *Ann Surg Oncol*. 2009; 16(2): 327-33.
16. Rivard JD, Temple WJ, McConnell YJ, Sultan H, Mack LA. Preoperative computed tomography does not predict resectability in peritoneal carcinomatosis. *AM J Surg*. 2014; 207(5): 760-4.
17. Kim EY, Lee WJ, Choi D, Lee SJ, Choi JY, Kim BT, Kim HS. The value of PET/CT for preoperative staging of advanced gastric cancer: comparison with contrast-enhanced CT. *Eur J Radiol*. 2011; 79:183-188.
18. Park K, Jang G, Baek S, Song H. Usefulness of combined PET/CT to assess regional lymph node involvement in gastric cancer. *Tumori*. 2014; 100:201-206.
19. Lopez-Lopez V, Cascales-Campos PA, Gil J, Frutos L, Andrade RJ, Fuster-Quinonero M et al. Use of 18F-FDG PET/CT in the preoperative evaluation of patients diagnosed with peritoneal carcinomatosis of ovarian origin, candidate for cytoreduction and HIPEC. A pending issue. *Eur J Radiol*. 2016; 85(10): 1824-8.
20. Dromain C, Leboulleux S, Auperin A, Goere D, Malka D, Lumbroso J et al. Staging of peritoneal carcinomas: enhanced CT vs PET/CT. *Abdom Imaging*. 2008; 33(1): 87-93.
21. Pasqual EM, Bacchetti S, Bertozzi S et al. Diagnostic accuracy of preoperative CT scan and 18F-FDG PET/CT in patients with peritoneal carcinomatosis undergoing hyperthermic intraperitoneal chemotherapy (HIPEC) following cytoreductive surgery. *Eur J Cancer*. 2013; 49:S264.
22. Leake P-A, Cardoso R, Seevaratnam R, Lourenco L, Helyer I, Mahar A et al. A systematic review of the accuracy and indications for diagnostic laparoscopy prior to curative-intent resection of gastric cancer. *Gastric Cancer* 2012; 15(S1): 38-47.
23. Low RN, Barone R, Lucero J. Comparison of MRI and CT for predicting the peritoneal cancer index (PCI) preoperatively in patients being considered for cytoreductive surgical procedures. *ANN Surg Oncol*. 2015; 22(5): 1708-15.
24. Low RN. Preoperative and surveillance MR imaging of patients undergoing cytoreductive surgery and heated intraperitoneal chemotherapy. *J Gastrointest Oncol*. 2016; 7(1): 58-71.

25. Michielsen K, Vergote I, Op De Beeck K, Amant F, Leunen K, Moerman P, et al. Whole-body MRI with diffusion-weighted sequence for staging of patients with suspected ovarian cancer: a clinical feasibility study in comparison to CT and FDG-PET/CT. *Eur Radiol*.2014; 24(4): 889-901.
26. Michielsen K, Dresen R, Vanslebrouck R, De Kezer F, Amant F, Mussen E, et al. Diagnostic value of whole body diffusion-weighted MRI compared to computed tomography for pre-operative assessment of patients suspected for ovarian cancer. *Eur J Cancer*. 2017; 83:88-98.
27. Koh D-M, Takahara T, Imai Y, Collins DJ. Practical aspects of assessing tumors using clinical diffusion-weighted imaging in the body. *Magn Reson Med Sci*. 2007;(6): 211-24.
28. Dresen RC, De Vuysere S, De Keyzer F, Van Cutsem E, Prenen H, Vanslebrouck R, De Hertogh G, Wolthuis A, D'Hoore A, Vandecaveye V. *Cancer Imaging* (2019); 19(1)
29. Giganti F, Tang L, Baba H. Gastric cancer and imaging biomarkers: Part 1 – a critical review of DW-MR and CE-MDCT findings. *European Radiology* (2019) 29: 1743-1753.
30. Tang L, Wang XJ, Baba H, Giganti F. Gastric cancer and image-derived quantitative parameters: Part 2 – a critical review of DCE-MRI and <sup>18</sup>F-FDG PET/CT findings. *European Radiology* published online 07 august 2019
31. De Cobelli F, Palumbo D, Albarello L, Rosati R, Giganti F. Esophagus and Stomach: Is there a role for MR Imaging? *Magn Reson Imaging Clin N Am* 28(2020) 1-15
32. Borggreve AS, Goense L, Brenkman H, Mook S, Meijer G, Wessels F, Verhey M, Jansen E, Van Hillegersberg R, Van Rossum P, Ruurda J. Review Article: Imaging strategies in the management of gastric cancer: current role and future potential of MRI. *Br J Radiol*; 92:20181044
33. Joo I, Lee JM, Kim JH, Shin D-I, Han JK, Choi BI. Prospective comparison of 3T MRI with diffusion-weighted imaging and MDCT for the preoperative TNM staging of gastric cancer. *J Magn Reson Imaging* 2015; 41: 814-21.
34. Soussan M, Des Guetz G, Barrau V, Aflalo-Hazan V, Pop G, Mehanna Z, et al. Comparison of FDG-PET/CT and MR with diffusion-weighted imaging for assessing peritoneal carcinomatosis from gastrointestinal malignancy. *Eur Radiol* 2012; 22: 1479-87.
35. Chua T, Al-Zahrini A, Saxena A, Glenn D, Liauw W, Zhao J et al. Determining the association between preoperative computed tomography findings and postoperative outcomes after cytoreductive surgery and perioperative intraperitoneal chemotherapy for pseudomyxoma peritonei. *Ann Surg Oncol*. 2011; 18(6): 1582-9.
36. Mazzei M, Khader L, Cirigliano A, Cioffi Squitieri N, Guerrini S, Forzoni B, et al. Accuracy of MDCT in the preoperative definition of peritoneal cancer index (PCI) in patients with advanced ovarian cancer who underwent peritonectomy and hyperthermic intraperitoneal chemotherapy (HIPEC). *Abdom Imaging*. 2013; 38(6): 1422-30.

## Tables

Tables 1-2 are not available with this version of the manuscript.

## Figures

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### Figure 1

A patient with an age-range between 60 and 70 years old was diagnosed with a primary gastric adenocarcinoma with signet ring cell differentiation, localized at the cardia. CT scan (a) showed the primary tumor (arrows) as well as hydronephrosis of the right kidney (\*), without a demonstrable cause. He had a WB-DWI/MRI for operability assessment. The primary gastric cancer is well visualized on the axial b1000 DWI (b, arrow). Apart from a peritoneal tumor implant on the right distal ureter (arrows) as the cause for the hydronephrosis on the coronal (c) and axial b1000 DWI (d), a brain metastasis (arrowheads) was found in the left cerebellum on the axial post-contrast T1 image (e) as well as the b1000 DWI (f), since the brain is included in the WB-DWI/MRI.

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### Figure 2

A patient with an age-range between 70 and 80 years old was diagnosed with primary gastric cancer, for which an endoluminal stent was placed. CT scan in the axial plane (a) with coronal reconstruction (b) did not show any metastases. WB-DWI/MRI was performed for operability assessment, revealing an adenopathy in the gastro-hepatic fat (c, arrowhead), as well as peritoneal metastasis in the falciform ligament and on the surface of the left liver lobe (c-e, arrows).

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### Figure 3

A patient with an age-range between 70 and 80 years old was diagnosed with primary gastric cancer. CT scan in the axial plane (a) with coronal reconstruction (b) did not show distant metastases. However, a slightly thickened anterior pararenal fascia on the left side (a, arrow) was noticed. WB-DWI/MRI was performed for further investigation with coronal (c) and axial b1000 (d) as well as contrast-enhanced T1-weighted images (e), and revealed – apart from the primary tumor (circled)– mesenteric tumor spread along the mesenteric root (c-e, arrows), as well as peritoneal tumor spread on the left anterior pararenal fascia (c, e, arrowheads).

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### Figure 4

A patient with an age-range between 60 and 70 years old with a primary gastric cancer, where CT did not show any distant metastases (a-b), underwent a WB-DWI/MRI for operability assessment. Axial b1000 DWI images revealed millimetric tumor implants on the pancreatic surface (c, arrowheads). At the same time, multiple bone metastases (arrows) could be seen on the coronal b1000 DWI (d), coronal T2-weighted images (e), axial b1000 DWI (f) and post-contrast T1-weighted images (g)