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Assessment of Role of Multidetector Computed Tomography and Virtual Gastroscopy in the Evaluation of Gastric Malignant Tumors

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ABSTRACT

Background: Gastric cancers have been examined using a wide variety of imaging techniques, including endoscopic ultrasound (US) and computed tomography (CT) imaging.

Objective: To highlight the efficacy of multislice computed tomography (MSCT) in the diagnosis and preoperative staging of gastric malignant tumors.

Subjects and methods: We carried out our comprehensive study at Radiodiagnosis Department, Zagazig University Hospitals on 18 patients with gastric cancer. Pregnant female, patients with impaired renal function, and allergy to contrast media were excluded. All patients were subjected to multidetector computed tomography (MDCT) of abdomen and pelvis.

Results: Histopathological diagnosis was significantly correlated with MDCT findings. The correlation between the final CT diagnosis and MDCT results was quite strong.

Conclusion: The local disease process of gastric cancer and its possible dissemination locations are evaluated using preoperative MDCT with contrast filling approach for abdomen and pelvis. Consider this data carefully while deciding between palliative and major surgical options. MultiPlanner reconstruction (MPR) and volume rendered (VR) are useful for evaluating tumor growth and are therefore given significant prognostic weight. Therefore, it is the preferred imaging method for the detection, evaluation, and staging of gastric cancers.

Keywords: Gastric neoplasm, Malignant gastric tumors, Multislice computed tomography.

INTRODUCTION

Despite a general downward trend, gastric neoplasm is still the fifth most frequent cancer and has the third highest fatality rate of any cancer kind [(1)].

Information about whether or not the cancer has spread to the lymph nodes (N staging) or other organs (M staging) from the stomach is helpful for planning treatment and estimating prognosis in patients with gastric cancer [(2)]. The results of the preoperative staging are crucial for guiding the selection of the best treatment options. Endoscopic mucosal excision for early stomach cancer and more drastic treatment for advanced stages are two of the current choices for gastric cancer therapy [(3)].

A good noninvasive imaging method, multidetector computed tomography is frequently utilized in the work-up of stomach cancer to assess both local and distant metastases [(4,5)]. Also, MDCT is utilized to track improvement while under therapy. Tumor invasion depth was evaluated and estimated using MultiPlanner reconstruction (MPR), and it was found to be a highly important predictive predictor in patients with stomach cancer [(6)].

Endoscopic ultrasonography (US) and magnetic resonance imaging (MRI) are just two of the many imaging modalities that have been utilised to assess gastric cancer (GC). However, due to its invasive nature and lack of accuracy when assessing more advanced forms of local or stenotic cancer as well as the detection of distant metastases, endoscopic ultrasonography is best reserved for determining the depth of wall invasion in early disease. Although there is a lack of sufficient research on the topic, magnetic resonance imaging appears to outperform other methods in terms of high resolution. Magnetic resonance imaging has limited applications in stomach cancer staging due to its high cost and lengthy scanning duration [(7)]. Contrast-enhanced CT and endoscopic ultrasonography are typically performed concurrently for precise preoperative staging [(8)].

We aimed at this work to highlight the efficacy of multislice computed tomography (MSCT) in the diagnosis and preoperative staging of gastric malignant tumors.

SUBJECTS AND METHODS

In this comprehensive research, 18 patients with gastric cancer were recruited. Pregnant female, patients with impaired renal function, and allergy to contrast media were excluded. We conducted the research at Radiodiagnosis Department, Zagazig University Hospitals.

All patients were subjected to the following:

Detailed personal, obstetric and medical history.

Radiological assessment:

MDCT Examination:

Machine: 128-slice MDCT was used for all studies (Phillips ingenuity, USA).

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Patient preparation:

- Results from renal function tests were of primary relevance when initially reviewing patient laboratory data.
- Patient wore relaxed comfortable clothing for the procedure.
- To ensure a thorough inspection, a 4-6 hour fast was recommended.
- For this reason, we advised them to keep drinking plain water up to three hours before the exam.
- In all cases, butyl scopolamine (10 mg) was given intravenously to lessen intestinal peristalsis.
- Oral administration of 6 g of effervescent granules in a very modest volume of water produces an effective degree of stomach distension. It was crucial since a collapsed gastric wall can mask sickness or make it appear if the entire stomach isn't well-distended.
- Using 18-20 gauge; the right antecubital vein was catheterized.

CT technique (Image acquisition):

- First, a prone CT scan was performed without intravenous contrast.
- Obtaining a scanogram was done to check for proper stomach distension.
- If the stomach was not sufficiently dilated, extra effervescent granules were given prior to supine scanning with a second scout image.
- At a rate of 3 ml/s, 150 ml of ionic contrast material (Iopamiro 300 or Ultravist 370) was injected intravenously through an 18-gauge angiographic catheter placed in the patient's antecubital vein.
- During the portal venous phase, which begins 70 seconds after contrast injection beginning, supine scanning was performed.
- Those are the CT scan settings that were used: Scanning the entire abdominal area using a slice thickness of 5 mm, a table feed of 8 mm, and an incremental reconstruction of 3 mm at 350 mA and 120 KV with a 0.5 second tube rotation time.

3D technique for virtual gastroscopy:

- For further editing, the 3D collection of reconstructed images was transferred via a network to a Philips Intellispace workstation.
- MPR, 2D/3D reformatting with volume rendering, and a virtual gastroscopy setup were the main tools for analysing volumetric images.
- Two-dimensional (2D) axial pictures were the primary data source for analysis of images. In order to further describe a lesion that was suspected on 2D axial pictures, 3D MultiPlanner reformatted (MPR) and virtual gastroscopy (VG) images were created.
- Comprehensive VG evaluation of the stomach could reveal subtle mucosal alterations in both prone and supine positions. The supine position is preferable to the prone one if the mass was located in the antrum or body, as these areas are inflated when lying prone. However, if the mass was located in the cardia or fundus, where it will be distended by air when lying prone, that position was recommended.
- Depending on the complexity of the data, volumetric analysis could take anywhere from 20 to 30 minutes per subject.

Image interpretation:

Two radiologists independently analyzed the cases with the aid of axial pictures, 3D (MPR), and the volume rendering technique. Comparisons were made between histological findings and endoscopic observations and final clinical diagnosis.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee [IRB Approval No. (#6302/12-08-2020)]. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Version 20.0 of the IBM SPSS application was utilised. To describe quantitative data, the range (minimum and maximum), mean, and standard deviation were used. Qualitative data were presented as frequency and percentage and were compared by Chi-square test. P value < 0.05 was considered significant.

RESULTS

Table (1) shows age and sex of the studied patients.

Table (1): Distribution of the studied cases according to personal data

	Cases (no=18)	
Age		
Range.	29 – 87	
Mean ± SD.	51.44 ± 15.03	
<30 years	1	5.6
30-40 years	2	11.1
40-50 years	7	38.9
50-60 years	4	22.2
>60 years	4	22.2
Gender		
Female	9	50.0
Male	9	50.0

Table (2) shows that among the studied cases, the most common MDCT findings were circumferential thickening in gastric outlet and obliterated peri-gastric fat planes.

Table (2): Distribution of the studied cases according to MDCT findings

	Cases (no=18)	
MDCT findings		
Well defined gastric mass	0	0.0
Diffuse irregular thickening of gastric wall	5	27.8
Circumferential thickening in gastric outlet	6	33.3
Irregular thickening of GE junction	2	11.1
Filling defects	2	11.1
Obliterated peri-gastric fat planes	6	33.3
Clear in between fat planes	1	5.6
Polypoidal mass	3	16.7
Extra gastric extension	4	22.2
Calcification	0	0.0
Soft tissue lesion	4	22.2
Cystic changes	0	0.0
Mixed solid and cystic component	1	5.6
Peritoneal deposits	2	11.1
Enhanced lesion	2	11.1
Hypodense	1	5.6
Isodense	3	16.7
Lesion containing gas vacuoles	1	5.6
Inhomogeneous density	1	5.6

Table (3) shows that among the studied cases irregular mass was the most common according to virtual gastroscopy.

Table (3): Distribution of the studied cases according to virtual gastroscopy

	Cases (no=18)	
Virtual gastroscopy		
Superficial elevated lesions	5	27.8
Mucosal changes	3	16.7
Polypoidal lesion	2	11.1
Hypertrophy of gastric folds with nodular surface	6	33.3
Irregular mass	7	38.9
Antral stenosis	2	11.1
Depressed lesions accompanied by fold convergence	2	11.1
Indentation in the gastric wall	5	27.8

Table (4) shows that there was no metastasis in 72.2% of the studied cases.

Table (4): Distribution of the studied cases according to association

	Cases (no=18)	
Association		
No L.N. involvement	5	27.8
Enlarged regional L.N.	5	27.8
Enlarged regional and other groups	8	44.4
Dilated GE junction	2	11.1
Local metastasis	2	11.1
Distant metastasis	2	11.1
No metastasis	13	72.2
Nodal mass complex	0	0.0

Table (5) shows that among the studied cases gastric carcinoma was the most common final diagnosis.

Table (5): Distribution of the studied cases according to final CT diagnosis

	Cases (no=18)	
Final CT diagnosis		
Gastric carcinoma	7	38.9
Lymphoma	5	27.8
GIST	4	22.2
Pedunculated GIST	1	5.6
Krukenberg tumors	1	5.6
Pancreatic cyst	0	0.0
Pancreatitis with pseudo cyst	0	0.0
Metastatic L.N. from cancer colon	0	0.0

Table (6) shows that among the studied cases 44.4% had adenocarcinoma.

Table (6): Distribution of the studied cases according to histopathological diagnosis by biopsy

	Cases (no=18)	
Histopathological diagnosis by biopsy		
Adenocarcinoma	8	44.4
Non-Hodgkin lymphoma	5	27.8
Gastro-intestinal stromal tumor	5	27.8

Table (7) shows that there was statistically significant relation between the histopathological diagnosis and MDCT findings.

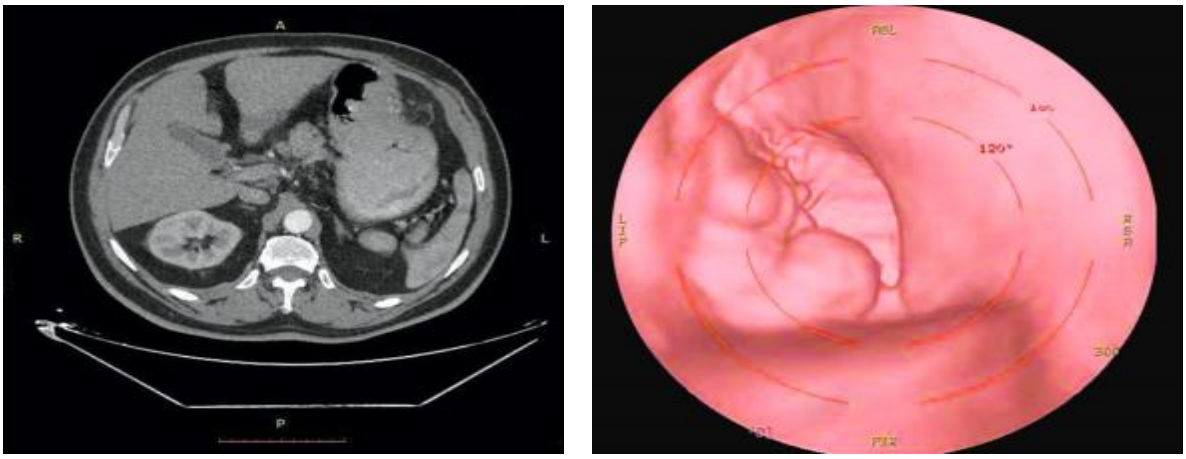
Table (7): Relation between histopathological diagnosis and MDCT findings

	Histopathological diagnosis						p-value
	Adenocarcinoma (n=8)		Non-Hodgkin lymphoma (n=5)		Gastro-intestinal stromal tumor (n=5)		
MDCT findings							
Diffuse irregular thickening of gastric wall	3	37.5	2	40.0	0	0.0	0.046*
Circumferential thickening in gastric outlet	3	37.5	3	60.0	0	0.0	
Irregular thickening of GE junction	2	25.0	0	0.0	0	0.0	
Filling defects	2	25.0	0	0.0	0	0.0	
Obliterated peri-gastric fat planes	4	50.0	0	0.0	2	40.0	
Clear in between fat planes	0	0.0	1	20.0	0	0.0	
Polypoidal mass	3	37.5	0	0.0	0	0.0	
Extra gastric extension	0	0.0	0	0.0	4	80.0	
Soft tissue lesion	3	37.5	0	0.0	1	20.0	
Mixed solid and cystic component	0	0.0	0	0.0	1	20.0	
Peritoneal deposits	1	12.5	0	0.0	1	20.0	
Enhanced lesion	1	12.5	0	0.0	1	20.0	
Hypodense	0	0.0	0	0.0	1	20.0	
Isodense	2	25	1	20.0	0	0.0	
Lesion containing gas vacuoles	0	0.0	0	0.0	1	20.0	
Inhomogeneous density	1	12.5	0	0.0	0	0.0	

Table (8) shows that there was high statistically significant relation between the final CT diagnosis and MDCT findings.

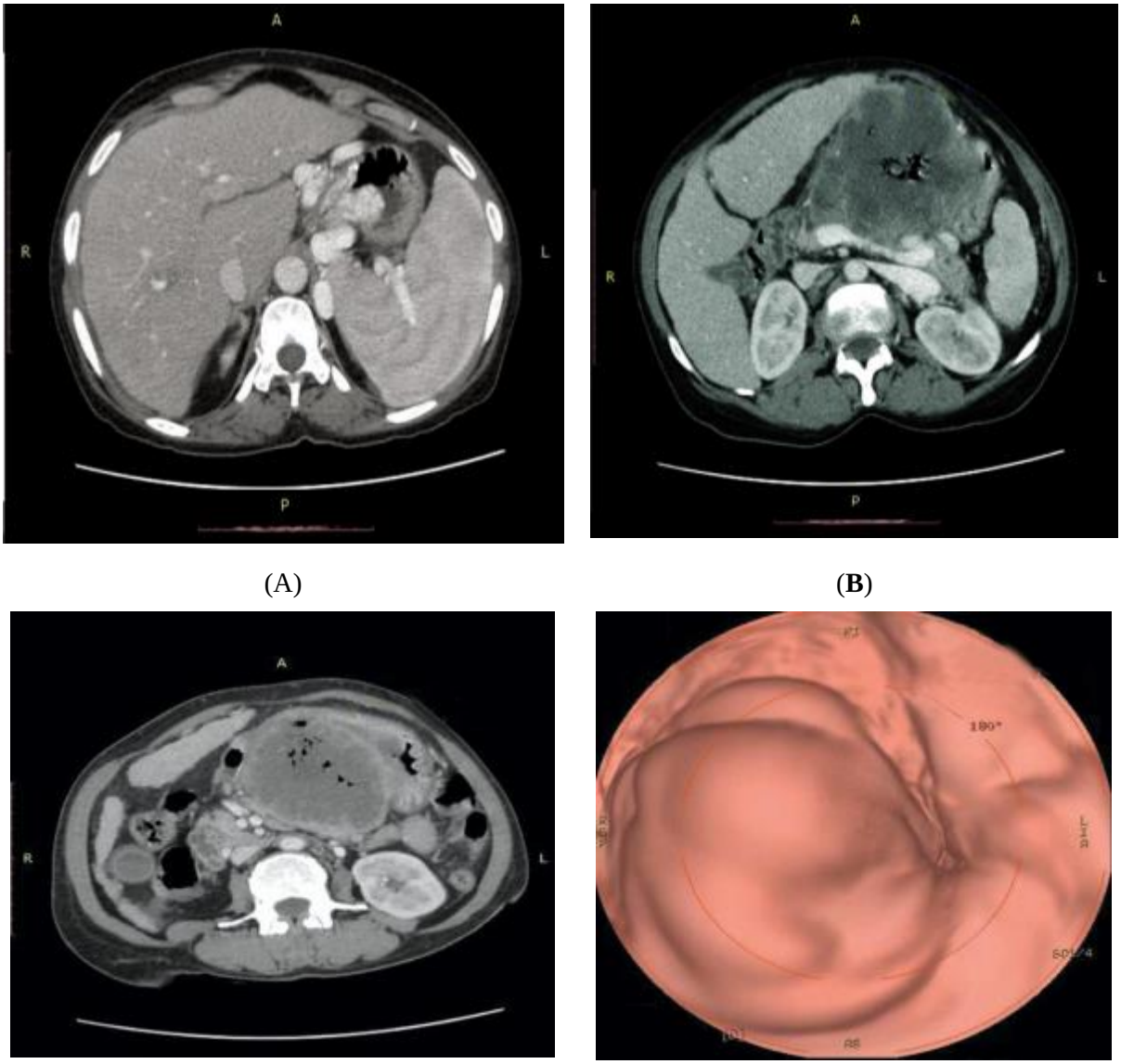
Table (8): Relation between final CT diagnosis and MDCT findings

	Histopathological diagnosis						P-value
	Adenocarcinoma (n=8)		Non-Hodgkin lymphoma (n=5)		Gastro-intestinal stromal tumor (n=5)		
Final CT diagnosis							
Gastric carcinoma	7	87.5	0	0.0	0	0.0	<0.001*
Lymphoma	0	0.0	5	100.0	0	0.0	
GIST	0	0.0	0	0.0	4	80.0	
Pedunculated GIST	0	0.0	0	0.0	1	20.0	
Krukenberg tumors	1	12.5	0	0.0	0	0.0	



(A) **(B)**

Figure (1): 47 years old male, complained of abdominal pain and fatigue. MDCT revealed: Multislice CT chest, abdomen and pelvis post I.V. contrast study (a): gastric greater curvature polypoidal wall thickening exerting mass like isodense soft tissue lesion measuring about 60 X 39 mm. Multiple abdominal (gastric, retro-pancreatic pre and bilateral para-aortic groups) enlarged L.N.s ranging from 8 to 14 mm. Few abdominal lymphadenopathies. Average size, fatty texture liver. Virtual gastroscopy revealed (b): A polypoidal lesion and hypertrophy of gastric folds with nodular surface. Final CT diagnosis: Gastric carcinoma. Histopathological diagnosis: Gastric adenocarcinoma.



(A) (**B**)

(C) (D)

Figure (2): 43 years old female, complained of abdominal pain and abdominal enlargement. MDCT revealed (A) and (B): Multislice triphasic CT abdomen and pelvis post IV contrast study revealed: -Large epigastric heterogeneously enhanced soft tissue lesion containing gas vacuoles inside measures about 112x109x122 mm. It is seen compressing and displacing stomach, and looks invading the lateral gastric wall (direct communication between the mass and stomach lumen), also, it is being inseparable from pancreatic body and tail, as well as, encasing related vascular structures and perigastric varices and abutting inferior surface of the left liver lobe with partial loss of in-between fat planes. Small upper abdominal epigastric perilesional, pre and para-aortic subcentimetric LNs. -Mildly enlarged size, co liver with small right liver lobe focal nodule at segment VIII measures about 12x10 mm showing heterogeneous enhancement at arterial phase with washout at venous and delayed phase. Enlarged size spleen with no focal masses. Dilated splenic hilar and perigastric varices. Minimal free ascites mainly at pelvis. Virtual gastroscopy revealed (C): Irregular mass and indentation in the gastric wall. Final CT diagnosis: Gastrointestinal stromal tumor. Histopathological diagnosis: Gastrointestinal stromal tumor.

DISCUSSION

In terms of cancer-related mortality, gastric cancer continues to be the second leading cause worldwide. Although its cause has yet to be identified, risk factors that are well recognized include Helicobacter pylori infection, poor diet, smoking, heavy alcohol consumption, and pernicious anemia [9].

There are new possibilities for upper GI imaging with multidetector computed tomography (MDCT). High-quality MultiPlanner reformation images of the esophagus, stomach, and gastrointestinal junction can be obtained with its use because of its rapid acquisition time and single-breath holding requirement [10].

In this study we found that the mean age of studied cases was 51.44 (±15.03 SD) with range (29-87) and among the studied cases there were 9 (50%) females and 9 (50%) males. This is in agreement with **Teama *et al.*** [11] who discovered that the sixth decade was the most at risk for stomach cancer.

In this study we cleared that according to MDCT findings there were 5 (27.8%) with diffuse irregular thickening of gastric wall, 6 (33.3%) with circumferential thickening in gastric outlet, 2 (11.1%) with irregular thickening of GE junction, 2 (11.1%) with filling defects, 6 (33.3%) with obliterated peri-gastric fat planes, 1 (5.6%) with clear in between fat planes, 3 (16.7%) with polypoidal mass, 4 (22.2%) with extra gastric extension, 4 (22.2%) with soft tissue lesion, 1 (5.6%) with mixed solid and cystic component, 2 (11.1%) with peritoneal deposits, 2 (11.1%) with enhanced lesion, 1 (5.6%) with hypodense, 3 (16.7%) with isodense, 1 (5.6%) with lesion containing gas vacuoles and 1 (5.6%) with inhomogeneous density. This is in agreement with the findings of **Teama *et al.*** [11] study, in which, 39 patients were diagnosed with malignant gastric tumours; 15 had circumferential mural thickening (15/39, 38.5%), 10 had focal irregular mural thickening of the gastric wall (10/39, 25.6%), 9 had polypoidal mass (9/39, 23.1%), and 5 had fungating soft tissue mass (5/39, 12.8%) with narrowing of the gastric lumen.

In this study we demonstrated that there were 5 (27.8%) with superficial elevated lesions, 3 (16.7%) with mucosal changes, 2 (11.1%) with polypoidal lesion, 6 (33.3%) with hypertrophy of gastric folds with nodular surface, 7 (38.9%) with irregular mass, 2 (11.1%) with antral stenosis, 2 (11.1%) with depressed lesions accompanied by fold convergence and 5 (27.8%) with indentation in the gastric wall.

Wani *et al.* [12] found that mucosal abnormalities were present in these patients using virtual CT gastrography. Tumors averaged 19.9 mm thick (between 7 and 40 mm). Early gastric cancer had a mean thickness of 10.14 mm (SD = 3.29) and advanced gastric cancer had a mean thickness of 20.84 mm (SD = 7.26) ($p < 0.05$).

In this study we illustrated that there were 5 (27.8%) with no L.N. involvement, 5 (27.8%) with enlarged regional L.N., 8 (44.4%) with enlarged regional and other groups, 2 (11.1%) with dilated GE junction, 2 (11.1%) with local metastasis, 2 (11.1%) with distant metastasis and 13 (72.2%) with no metastasis. This is agreed with **Sun *et al.*** [13] they discovered that 21% of patients showed up to their diagnosis with evidence of distant metastases, and that 50% of those patients had metastatic illness to the liver, the most common metastatic organ.

Since MDCT combines fast imaging with intravenous contrast and 3D imaging capabilities, it is ideal for detecting distant metastases with stomach cancer. Although detection of metastases to solid organs is unusual at the time of initial diagnosis of primary gastric tumours, it is crucial for treatment planning. Due to the stomach's draining portal vein, the liver is frequently affected by hematogenous metastases from gastric cancer (PV). The presence of peritoneal metastases is an exceptionally dismal prognostic indicator. Peritoneal metastases are diagnostic of an incurable illness [14].

In this study we demonstrated that according to CT final diagnosis, there were 7 (38.9%) with gastric carcinoma, 5 (27.8%) with lymphoma, 4 (22.2%) with GIST, 1 (5.6%) with pedunculated GIST and 1 (5.6%) with Krukenberg tumors. **In the study of Teama *et al.*** [11] 14 patients (34.9%) were diagnosed with gastric cancer, 9 patients (20.5%) with round cell carcinoma, 7 patients (17.9%) with lymphoma, and 5 patients (5.2%) were diagnosed with GISTs (12.8 percent).

In this study we found that according to histopathological diagnosis by biopsy, there were 8 (44.4%) with adenocarcinoma, 5 (27.8%) with lymphoma and 5 (27.8%) with gastro-intestinal stromal tumor. This is in agreement with **Liu *et al.*** [7] who found that undifferentiated adenocarcinoma was more prevalent in their study's participants than poorly differentiated adenocarcinoma, while **Shimizu *et al.*** [15], found the opposite.

Our results showed that there was statistically significant relation between the histopathological diagnosis and MDCT findings. This is in agreement with the results of **Yan *et al.*** [16], as they found that the sensitivity of MSCT for detecting stomach cancer was between 68.8 and 96.2 percent.

Our study findings were in accordance with the study by **Barros *et al.*** [17] wherein it was determined that preoperative staging of gastric cancer with 64-channel multi-detector CT showed clinically significant accuracy with regards to invasion depth (T) and metastatic involvement (M). **Sharara *et al.*** [18] compared MDCT T staging to pathological staging and found that MDCT T

staging was significantly more accurate. To help decide between palliative and radical surgical treatment, MDCT is used to distinguish between benign and malignant gastric neoplasm and to identify the stage and stomach dissemination of gastric cancer. Also, MDCT is utilized to track improvement while under therapy. Furthermore, it has been demonstrated to be a highly important prognostic factor in patients with stomach cancer by measurement and estimation of tumor invasion depth after MPR [19].

In the present study, we found that there was high statistically significant relation between the final CT diagnosis and histopathological diagnosis. **Yogaraj *et al.*** [20] found that Multi-detector CT was an effective imaging method for the stomach based on the correlation between histology results and CT diagnosis. **Zytoon *et al.*** [21] found that CT was found to be specific and accurate in the detection of all stages of gastric cancer, with specificity ranging from 93–97% and accuracy ranging from 9–92.5%. This suggests a strong correlation between the two methods of diagnosis.

CONCLUSION

Multidetector computed tomography with MultiPlanner reconstruction and virtual gastroscopy is currently a useful all-in-one diagnostic method for diagnosis of different gastric tumors and early detection of most of them especially in preoperative evaluation of patients with known, or strongly suspected gastric cancer.

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REFERENCES

1. **Bray F, Ferlay J, Soerjomataram I *et al.* (2018):** Global Cancer Statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin., 68(6):394-424.
2. **Smyth E, Verheij M, Allum W *et al.* (2016):** Gastric cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol., 27: 38–49.
3. **Yan C, Bao X, Shentu W *et al.* (2016):** Preoperative gross classification of gastric adenocarcinoma: comparison of double contrast-enhanced ultrasound and multi-detector row CT. Ultrasound Med Biol., 42:1431–144.
4. **Tsurumaru D, Miyasaka M, Nishimuta Y *et al.* (2016**) Differentiation of early gastric cancer with ulceration and resect- able advanced gastric cancer using multiphasic dynamic multidetector CT. Eur Radiol., 26(5):1330–1337.
5. **Saito T, Kurokawa Y, Takiguchi S *et al.* (2015)** Accuracy of multidetector-row CT in diagnosing lymph node metastasis in pa- tients with gastric cancer. Eur Radiol., 25(2):368–374.
6. **Shin K, Kim S, Han J *et al.* (2007):** Three-dimensional MDCT gastrography compared with axial CT for the detection of early gastric cancer. J Comput Assist Tomogr., 31:741–749.
7. **Liu S, Liu S, Ji C *et al.* (2017):** Application of CT texture analysis in predicting histopathological characteristics of gastric cancers. Eur Radiol., 27(12):4951-4959.
8. **Kwee R, Kwee T (2008):** The accuracy of endoscopic ultrasonography in differentiating mucosal from deeper gastric cancer. Am J Gastroenterol., 103:1801–1809.
9. **Wang L, Zhao S, Lv G *et al.* (2020):** Mechanisms of resveratrol in the prevention and treatment of gastrointestinal cancer. World Journal of Clinical Cases, 8(12): 2425-37.
10. **He P, Miao L, Ge H *et al.* (2019):** Preoperative tumor staging of gastric cancer: Comparison of double contrast-enhanced ultrasound and multidetector computed tomography. Journal of Ultrasound in Medicine, 38(12): 3203-3209.
11. **Teama A, El-Badry A, Yousef E (2016):** The role of multislice computed tomography in the diagnosis of gastric malignant tumors. Tanta Medical Journal, 44(3): 119-23.
12. **Wani A, Parry A, Feroz I *et al.* (2021):** Preoperative staging of gastric cancer using computed tomography and its correlation with histopathology with emphasis on Multi-Planar Reformations and virtual gastroscopy. Journal of Gastrointestinal Cancer, 52(2): 606-615.
13. **Sun Z, Zheng H, Yu J *et al.* (2019):** Liver metastases in newly diagnosed gastric cancer: a population-based study from SEER. Journal of Cancer, 10(13): 2991-3005.
14. **Almeida M, Verza L, Bitencourt A *et al.* (2018):** Computed tomography with a stomach protocol and virtual gastroscopy in the staging of gastric cancer: an initial experience. Radiologia Brasileira, 51: 211-217.
15. **Shimizu H, Ichikawa D, Komatsu S *et al.* (2012):** The decision criterion of histological mixed type in "T1/T2" gastric carcinoma--comparison between TNM classification and Japanese Classification of Gastric Cancer. Journal of Surgical Oncology, 105(8): 800–804.
16. **Yan C, Zhu Z, Yan M *et al.* (2009):** Value of multidetector-row computed tomography in the preoperative T and N staging of gastric carcinoma: A large-scale Chinese study. Journal of Surgical Oncology, 100(3): 205-214.
17. **Barros R, Penachim T, Martins D *et al.* (2015):** Multidetector computed tomography in the preoperative staging of gastric adenocarcinoma. Radiologia Brasileira, 48: 74-80.
18. **Sharara S, Nagi M, Soliman S (2018):** Multidetector computed tomography in the evaluation of gastric malignancy; A multicenteric study. The Egyptian Journal of Radiology and Nuclear Medicine, 49(2): 304-309.
19. **Lu J, Hu D, Tang H *et al.* (2019):** Assessment of tumor heterogeneity: Differentiation of periampullary neoplasms based on CT whole-lesion histogram analysis. European Journal of Radiology, 115: 1-9.
20. **Yogaraj S, Kumar M (2019):** 128 slices multidetector CT evaluation of gastric carcinoma-imaging and histopathological correlation. International Archives of Integrated Medicine, 6(4): 60-63.
21. **Zytoon A, El-Atfey S, Hassanein S (2020):** Diagnosis of gastric cancer by MDCT gastrography: diagnostic characteristics and management potential. Egyptian Journal of Radiology and Nuclear Medicine, 51(1): 1-7.