

Original Article

Analysis of application effects of ultrasonic aid in gastric cancer screening

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Abstract: Objective: To analyze the application effects of ultrasonic aid in screening of gastric cancer. Methods: Clinical data of 108 patients with suspected gastric cancer were retrospectively reviewed, including 72 cases of gastric cancer and 36 cases of gastric ulcer verified through surgery and pathological examination. Contrast examination with oral ultrasonic aid and gastroscopy were performed for all the patients. With pathologic diagnosis results as the gold standard, the efficiency of contrast examination with oral ultrasonic aid and gastroscopy in diagnosing gastric cancer was analyzed, and the diagnostic coincidence rates of contrast examination with oral ultrasonic aid and gastroscopy were compared. Additionally, the capacity of contrast examination with oral ultrasonic aid in judging early and advanced gastric cancer as well as depth of gastric wall invasion was analyzed. Results: The sensitivity of contrast examination with oral ultrasonic aid in diagnosing gastric cancer was 100.00%, the negative predictive value was 100.00%, the positive predictive value was 92.31%, and the specificity was 83.33%. In contrast, for gastroscopy in diagnosing gastric cancer, the sensitivity, negative predictive value, positive predictive value and specificity were 83.33%, 68.42%, 85.71% and 72.22%, respectively. McNemar's test indicated that there was no statistically significant difference between contrast examination with oral ultrasonic aid and gastroscopy ($P=0.200$, $P>0.05$). On diagnosing early gastric cancer, sensitivity of contrast examination with oral ultrasonic aid was 80.00%, and the specificity was 84.62%. On diagnosing advanced gastric cancer, the sensitivity and specificity of the examination were 84.62% and 80.00%, respectively. The coincidence rate between depth of gastric wall invasion and pathological staging determined through contrast examination with oral ultrasonic aid was 72.22%. The coincidence rate of too deep judgment was 19.44%, and that of too shallow judgment was 8.33%. Conclusion: Contrast examination with oral ultrasonic aid can be used as an ideal inspection method for screening of gastric cancer, which has a high efficiency of gastric cancer diagnosis and clinical staging and can accurately determine the depth of gastric wall invasion. It is especially applicable for preoperative assessment of gastric cancer, with the advantages of being a simple, noninvasive, safe, and economical, alternative which is worthy of further research and application.

Keywords: Gastric cancer, ultrasonic aid, gastroscopy, screening

Introduction

The incidence rate of gastric cancer is rising in recent years. According to survey data from the International Agency for Research on Cancer, there were nearly 950,000 new cases of gastric cancer around the globe as of 2012, and more than 700,000 patients died from gastric cancer, which are increasing constantly [1]. In China, gastric cancer has become one of the most common malignant tumors, with incidence rate and death rate ranking 5th and 6th, respectively, in the world, and the burden caused by gastric cancer is growing day by day.

However, a substantial number of patients are in the advanced stage at diagnosis, and the treatment effects are not ideal. Therefore, it is necessary to conduct diagnosis early and assess the disease conditions and prognosis accurately, so as to guide treatment [2]. Previous methods for detecting gastric cancer are dominated by gastroscopy, X-ray barium meal and conventional ultrasound, but gastroscopy cannot judge the depth of gastric wall invasion and distant metastasis of gastric cancer, and some patients have intolerance to gastroscopy [3]. The X-ray barium meal, however, is unable to determine the nature of lesion and has a cer-

tain radiation effect on the patients. Seeing that the conventional ultrasound is influenced by gas, mucus, gastric contents, etc. in the gastric cavity during screening of gastric cancer, its capability of diagnosis and differential diagnosis of gastric cancer is decreased [4, 5]. As contrast examination with oral ultrasonic aid has popularized in recent years, it can not only clearly display the structure of gastric wall and invasion depth of lesion, but also be more acceptable to the patients [6, 7]. Although the contrast examination with oral ultrasonic aid is expected to become an ideal method to screen gastric cancer due to the abovementioned advantages, its diagnostic efficiency still remains uncertain, and controversy exists as to whether contrast examination with oral ultrasonic aid can replace gastroscopy in screening the disease. There are few studies on the comparison of diagnostic efficiency in gastric cancer between contrast examination with oral ultrasonic aid and gastroscopy, and no unified conclusion has been obtained. To this end, this study aims to analyze the application effects of ultrasonic aid in screening of gastric cancer.

Materials and methods

General data

The clinical data of 108 patients with suspected gastric cancer admitted and treated in Jining No.1 People's Hospital from January 2016 to January 2017 were retrospectively reviewed, and this study was approved by the Ethics Committee of Jining No.1 People's Hospital.

There were 72 cases of gastric cancer verified through surgery and pathological examination, including 45 males and 27 females aged 26-78 years old, with an average age of (46.9 ± 11.3) years old, course of disease of 3 months to 3 years, and average course of (1.22 ± 0.67) years. Among the 36 cases of gastric ulcer verified through surgery and pathological examination, there were 19 men and 17 women aged 28-79 years old, with an average age of (47.9 ± 12.4) years old. The course of disease was 2 months to 2.7 years, with average course of (0.98 ± 0.44) years.

Inclusion criteria: 1) Patients with clinical symptoms such as pain, discomfort or tenderness in the left upper quadrant of the abdomen, palpable masses, acid reflux, and belching; 2)

Patients confirmed by surgery and pathological examination; 3) Patients with data of contrast examination with oral ultrasonic aid and gastroscopy; 4) Patients without contraindications to the examinations. All the patients and their families agreed with this study before examinations and signed the informed consent.

Exclusion criteria: 1) Patients unsuitable for contrast examination with oral ultrasonic aid and gastroscopy due to acute gastric bleeding, stomach dilatation and gastric perforation; 2) Patients allergic to the ultrasonic aid.

Contrast-enhanced ultrasound

The GE Voluson730 color Doppler ultrasonic diagnostic apparatus with a 4°C probe at frequency of 7.5-10.0 MHz was utilized. The ultrasonic aid (specification: 50 g/bag) produced by Huzhou Dongya Medical Supplies Co., Ltd. was adopted. The patients were fasted for more than 8 h before the examinations, and the ultrasonic aid was prepared at 30 min ahead of the examinations. And 50 g of the ultrasonic aid was taken every time, made in to a paste with 100 mL pure water at about 40°C, and diluted with 400 mL boiled water at about 90°C. The dose could be reduced to 400 mL in elder patients according to the circumstances. Patients were scanned via direct contact method in sitting, decubitus, and lateral positions, respectively, in which the fundus, body, antrum, and pylorus of the stomach were scanned in turn. In the processes of fasting scanning, the morphological structure of the stomach and conditions of peripheral organs were mainly observed. After the prepared ultrasonic aid was administered to the patients, the morphology of the gastric cavity, structure of the gastric wall, formation of lesion as well as morphology, size, location, and distribution of lesion were observed in detail. Gastroscopy was performed after the contrast examination with oral ultrasonic aid, and the patients were asked to keep in the right lateral decubitus. If the posture could not be maintained, the left lateral decubitus or sitting position was also applicable. Continuous scanning was conducted with a probe, in which the cardia, body, fundus, antrum, and greater and lesser curvatures of the stomach, as well as duodenal bulb, distant lymph node, and abdominopelvic cavity were observed in sequence. In case of masses, the location and morphology of the tumor were

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Table 1. Analysis of diagnostic efficiency of contrast examination with oral ultrasonic aid in gastric cancer (n, %)

Contrast examination with oral ultrasonic aid	Pathological examination		Total
	Gastric cancer	Gastric ulcer	
Gastric cancer	72 (92.31)	6 (7.69)	78 (100.00)
Gastric ulcer	0	30 (100.00)	30 (100.00)
χ^2			83.077
P			0.031

Table 2. Analysis of diagnostic efficiency of gastroscopy in gastric cancer (n, %)

Gastroscopy	Pathological examination		Total
	Gastric cancer	Gastric ulcer	
Gastric cancer	60 (85.71)	10 (14.29)	70 (100.00)
Gastric ulcer	12 (31.58)	26 (68.42)	38 (100.00)
χ^2			32.481
P			0.832

labeled, and its size, depth of invasion and metastasis were measured [8].

Diagnostic criteria

All the imaging data were reviewed by two experienced medical imaging doctors using a blinded method. If the results between the two doctors were not identical, the images would be reviewed by a third doctor, and the final results should be obtained through discussion. The diagnosis was performed according to the diagnostic criteria jointly issued by the American Joint Committee on Cancer and Union for International Cancer Control (UICC). Most of the contrast-enhanced ultrasound results were manifested as low-level echo and non-uniformity of the gastric lesion, thickening, eminence, and discontinuity of the gastric wall, uneven mucous surface and declined gastric peristalsis function. The infiltration of early gastric cancer is often limited in the mucosa or submucosa, but that of advanced gastric cancer generally exceeds the muscularis propria [6]. In gastroscopy, local redness or paleness of the mucous of gastric cancer was visible. There were erosions, bleeding, granules or nodules, disordered or disappeared vessel shape, abnormal tumor vascularization, disordered or disappeared pit patterns, etc. Meanwhile, with the postoperative pathology as the gold standard for diagnosis, the sensitivity, negative predictive value, positive predictive value, specificity and diagnostic coincidence rate of contrast

examination with ultrasonic aid and gastroscopy were calculated, respectively. Whether the coincidence rate was too deep or too shallow was assessed in accordance with the actual depth of gastric wall invasion. The staging judgment of gastric cancer exceeding the actual depth of invasion was regarded as coincidence rate of too deep judgment. If the staging judgment of gastric cancer was lower than the actual depth of invasion, it was regarded as coincidence rate of too shallow judgment. Pathological staging of the gastric cancer was performed according to the tumor-node-metastasis staging standard published by the UICC.

Data processing

SPSS 18.0 software was used to process the experimental data. The measurement data conforming to normal distribution and homogeneity of variance are expressed as mean \pm standard deviation, and t-test was applied for comparison between two groups. The enumeration data were examined via paired χ^2 test, of which McNemar's test was performed for comparison between contrast examination with oral ultrasonic aid and gastroscopy. $P < 0.05$ suggests that the difference is statistically significant.

Results

Analysis of diagnostic efficiency of contrast examination with oral ultrasonic aid and gastroscopy in gastric cancer

The sensitivity of contrast examination with oral ultrasonic aid in diagnosing gastric cancer was 100.00%, the negative predictive value was 100.00%, the positive predictive value was 92.31%, and the specificity was 83.33%. There was a statistically significant difference in the diagnosis of gastric cancer between contrast examination with oral ultrasonic aid and pathological examination ($P = 0.031$, $P < 0.05$; **Table 1**). As for the gastroscopy in diagnosing gastric cancer, the sensitivity, negative predictive value, positive predictive value, and specificity were 83.33%, 68.42%, 85.71% and 72.22%, respectively. However, the difference in the diagnosis of gastric cancer between gastro-

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Table 3. Comparison of contrast examination with oral ultrasonic aid and gastroscopy in gastric cancer (n, %)

Gastroscopy	Contrast examination with oral ultrasonic aid		Total
	Gastric cancer	Gastric ulcer	
Gastric cancer	59 (84.29)	11 (15.71)	70 (100.00)
Gastric ulcer	19 (50.00)	19 (50.00)	38 (100.00)
χ^2			14.432
P			0.200*

Note: *McNemar test.

Table 4. Analysis of diagnostic efficiency of contrast examination with oral ultrasonic aid in early and advanced gastric cancer (n, %)

Contrast examination with oral ultrasonic aid	Pathological examination		Total
	Early gastric cancer	Advanced gastric cancer	
Early gastric cancer	16 (66.67)	8 (33.33)	24 (100.00)
Advanced gastric cancer	4 (8.33)	44 (91.67)	48 (100.00)
χ^2			27.138
P			0.388

Table 5. Analysis of judgment of depth of gastric wall invasion via contrast examination with oral ultrasonic aid (n, %)

Pathological stage	Case	Contrast examination with oral ultrasonic aid			
		T1	T2	T3	T4
T1	20	14 (70.00)	6 (30.0)	0	0
T2	16	2 (12.50)	8 (50.00)	6 (37.50)	0
T3	26	0	4 (15.38)	20 (76.92)	2 (7.69)
T4	10	0	0	0	10 (100.00)
Total	72	16 (22.22)	18 (25.00)	26 (36.11)	12 (16.67)
χ^2					0.744
P					0.863

copy and pathological examination was not statistically significant ($P=0.832$, $P>0.05$; **Table 2**). The McNemar's test indicated that there was no statistically significant difference in the diagnostic efficiency between contrast examination with oral ultrasonic aid and gastroscopy in gastric cancer ($P=0.200$, $P>0.05$; **Table 3**).

Analysis of diagnostic efficiency of contrast examination with oral ultrasonic aid in early and advanced gastric cancer

On diagnosing early gastric cancer, the sensitivity of contrast examination with oral ultrasonic aid was 80.00%, and the specificity was

84.62%. On diagnosing advanced gastric cancer, the sensitivity and specificity of the examination were 84.62% and 80.00%, respectively. It was manifested in the McNemar's test that the difference in the diagnostic efficiency between contrast examination with oral ultrasonic aid and pathological examination in gastric cancer was not statistically significant ($P=0.388$, $P>0.05$; **Table 4**).

Analysis of judgment of depth of gastric wall invasion via contrast examination with oral ultrasonic aid

The coincidence rate between the depth of gastric wall invasion and pathological staging as determined through contrast examination with oral ultrasonic aid was 72.22% (52/72), the coincidence rate of too deep judgment was 19.44% (14/72), and that of too shallow judgment was 8.33% (6/72) as shown in **Table 5**.

Discussion

In terms of gastric cancer screening, it is a hotspot and difficulty for previous studies to search for a conventional imaging technique that can avoid the limitations of gastroscopy, X-ray barium meal, and conventional ultrasound, but can detect disease rapidly and accurately. Compared with con-

ventional ultrasound, contrast examination with oral ultrasonic aid can remarkably increase the diagnostic coincidence rate for gastric diseases. The reason is that the examination can quickly exclude the impacts of gas, mucus, and gastric contents in the gastral cavity on the definition of ultrasound images, so it can clearly display the hierarchical structure of the gastric wall, which provides an important basis for determining existence of lesions in the gastric wall, extent of the lesion and depth of gastric wall invasion, thus avoiding unnecessary gastroscopy [7, 8]. Some scholars have studied and revealed that the major mechanism of gastric contrast-enhanced ultrasonography with

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ultrasonic aid was that the agent can decrease the surface tension of residual air bubbles in the stomach and break them up [9]. At the same time, the ultrasonic aid can accumulate on the mucous of the lesion to form a distinct interface, so as to confirm changes in the thickness and morphological structure of the gastric wall. In this study, contrast examination with oral ultrasonic aid was successfully applied to 108 patients with suspected gastric cancer. It is easy to operate and has high acceptability and excellent reactivity. Moreover, the agent is good-tasting and absorbable since it is made of cereals. No serious adverse reactions occurred in the patients of this study during administration, and only 3 patients had mild symptoms such as abdominal distension and nausea due to eating too fast. All the symptoms were relieved after the patients were asked to breathe deeply and slow down the eating. By this way, the distress caused by gastroscopy and radiation produced by X-ray barium meal are avoidable. The results of this study showed that the sensitivity of contrast examination with oral ultrasonic aid in diagnosing gastric cancer was 100.00%, the negative predictive value was 100.00%, the positive predictive value was 92.31%, the specificity was 83.33%, and the diagnostic coincidence rate was 94.44%, which are consistent with the domestic and foreign research reports. The diagnostic coincidence rate of contrast examination with oral ultrasonic aid was not statistically different from that of gastroscopy (79.63%; $P > 0.05$), indicating that the contrast examination with oral ultrasonic aid can be used as an effective supplement of gastroscopy as well as prescreening tool [10, 11].

In view of significant differences in the biological characteristics of varied histologic types of gastric cancer, such as age, gender and degree of differentiation, 72 patients with gastric cancer were selected in this study to undergo the contrast examination with oral ultrasonic aid, and it was discovered that adenocarcinoma was the main type. The study conducted by Yuan showed that among the 85 patients with advanced gastric cancer who were examined by virtue of ultrasonic aid, there were 21 cases of moderately- and well-differentiated adenocarcinoma, 38 cases of poorly differentiated adenocarcinoma, 18 cases of signet-ring cell carcinoma, and 8 cases of medullary carcinoma [12]. It suggests that this study is consis-

tent with other literature reports. The gastric cancer can be divided into four subtypes according to its specific morphology, namely, mass type, ulcerative type, local infiltrating type, and infiltrative type. In this study, typing diagnosis was performed for the four subtypes of gastric cancer through oral ultrasonic aid and gastroscopy, and excellent effects were achieved. Different examination results for the four subtypes of gastric cancer lesions are displayed via the contrast examination with oral ultrasonic aid [13]. As for the lesion of mass type gastric cancer, it is relatively limited, with fairly intact mucous of the gastric wall, low-level echo, coarse surface of the mass which grows on the mucous surface and projects into the gastral cavity. The lesion of ulcerative type gastric cancer is manifested as growth toward the surface of gastric mucous, infiltration around the gastric wall and depression formed in the center of lesion. The lesion of local infiltrating type gastric cancer mainly invades a part of the stomach, and the local thickening of the gastric wall is visible. In terms of the lesion of infiltrative type gastric cancer, there is unclear hierarchical structure of the gastric wall, wide infiltration range and declined gastric peristalsis function [14, 3]. Therefore, based on the above viewpoints, it can be seen that the contrast examination with oral ultrasonic aid plays a crucial role in the preoperative assessment of gastric cancer because it can eliminate the interference of gas and mucus in the stomach and clearly display the hierarchical structure of the gastric wall [15]. Furthermore, clinical classification is performed according to the imaging features of the lesion, so as to guide the treatment. The research of Cardoso indicated that the contrast examination with oral ultrasonic aid can clearly display the deep structure of the gastric wall, which is widely applied in screening of gastric cancer and preoperative staging [16]. In this study, the main purpose of using the contrast examination with oral ultrasonic aid to determine the depth of gastric wall invasion is to clarify the infiltration range of the cancer and differentially diagnose the early and advanced gastric cancer, thus providing a basis for deciding the surgical program.

A study on the survival rate of gastric cancer indicated that the 5-year survival rate of early gastric cancer is as high as 90%, but that of advanced gastric cancer is only about 35%. If the cancer infiltrates into the outer layer of

serosa, the 5-year survival rate will be less than 12% [17]. Based on those views, the key to improving treatment level for gastric cancer and extending survival time lies in early diagnosis of the disease. In consequence, it was particularly important to analyze the judgment of early and advanced gastric cancer as well as the depth of gastric wall invasion through contrast examination with oral ultrasonic aid in this study. It is always difficult to diagnose early gastric cancer by means of ultrasound because its lesion is relatively limited, with fairly intact mucous of the gastric wall, low-level echo, and a coarse surface of the mass which grows on the mucous surface and inconspicuous thickening of the gastric wall [18]. In this study, however, the key to diagnosing early gastric cancer by means of contrast examination with oral ultrasonic aid was to observe the clarity of the gastric submucosal line. The results show that the sensitivity of contrast examination with oral ultrasonic aid in diagnosing early gastric cancer is 80.00%, and the specificity is 84.62%. On diagnosing advanced gastric cancer, the sensitivity and specificity of the examination were 84.62% and 80.00%, respectively, which were higher than those in the Chinese literature [19]. In addition, it can be seen from **Table 5** that the coincidence rate of depth of gastric wall invasion determined through contrast examination with oral ultrasonic aid is 72.22%, of which the coincidence rate of too deep judgment is 19.44%, and that of too shallow judgment is 8.33%. This sufficiently proves that contrast examination with oral ultrasonic aid plays an active role in preoperative assessment of gastric cancer and guidance of treatment. However, contrast examination with oral ultrasonic aid cannot directly determine the nature of early gastric cancer and gastric diseases with small lesions. In addition, the ultrasonic images of the patients with residual chyme in the stomach, fat figure, or lesions covered by the ribs are poor, thus they need to be further examined through gastroscopy or pathological examination [20]. Furthermore, the distribution of the ultrasonic aid may have great impacts on the definition of the ultrasonic images, so different postures are required during the contrast examination with oral ultrasonic aid, which is conducive to distributing the ultrasonic aid evenly and observing the lesions and gastric wall from various directions.

In conclusion, contrast examination with oral ultrasonic aid can be used as an efficient inspection method for screening gastric cancer, which has high efficiency in gastric cancer diagnosis and clinical staging and can be taken as a method for preliminary assessment of the depth of gastric wall invasion. It is especially applicable for preoperative assessment of gastric cancer, with the advantages of being simple, noninvasive, safe, and economical, which is worthy of further research and application. However, its diagnostic efficiency in different gastric diseases (gastric ulcer and pre-neoplastic lesions) was not evaluated and compared in this preliminary study, which will be investigated in future research.

Disclosure of conflict of interest

None.

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