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CASE REPORT

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Spectral CT findings of bladder urothelial carcinoma with gastric metastasis: a case report

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Abstract

Background Bladder cancer is one of the most common cancers worldwide, and urothelial carcinoma is the most common form of bladder cancer. Gastric metastasis of urothelial carcinoma of the bladder is a rare condition. Cystoscopy plays an important role in the diagnosis of bladder cancer; however, it is an invasive procedure that may affect the patient's prognosis and does not allow for the observation of cancer infiltration and metastasis. Therefore, non-invasive imaging is increasingly becoming the most appropriate method for the diagnosis and follow-up of urothelial carcinoma.

Case presentation A 51-year-old female patient presented with pain in the lower abdomen and lower back for more than 2 months. This was a case of bladder urothelial carcinoma with gastric metastases, confirmed by pathology using dual-layer detector computed tomography (CT) spectral multiparametric imaging. The stage of the cancer was cT3N+M1b IVB, and the dimensions were 11.6 mm×42.2 mm×44.4 mm. The energy spectrum multiparameter image shows good consistency in the quantitative measurement of multiple nodules on the gastric wall and bladder wall masses (single energy 40 keV-CT value, iodine concentration, effective atomic number), and the spectral curve runs basically consistent. After 5 months of chemotherapy, the slope values of the spectral curve were 3.74 and 3.09 in the initial and follow-up spectral CT scans, respectively, reflecting the improvement of bladder wall lesions after treatment.

Conclusions The present case is a very rare case of bladder urothelial carcinoma with gastric metastasis. We applied multi-parameter quantitative indicators of spectral CT to more accurately show the homology characteristics of gastric metastasis and bladder cancer, and also reflected the different sources of cystic lesions in the left adnexal region from bladder cancer and gastric metastasis. Spectral CT has a promising application prospect in detecting the homology of different lesions and diagnosing urothelial gastric metastasis carcinoma.

Keywords Spectral CT, Urothelial carcinoma, Gastric metastasis, Case report

Background

Bladder cancer is a common malignant tumor of the urinary system. Statistics on 36 types of cancer across 185 countries and regions worldwide in 2022 showed that bladder cancer ranked 9th, with an incidence rate of 3.1% [1].Pathologic features and accurate staging significantly influence the prognosis and progression of bladder cancer [2]. As the most common histological type of bladder cancer, urothelial carcinoma mainly invades the surrounding tissues and metastasizes to distant organs at a later stage [3]. The metastatic disease rate was 29%,

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with common metastatic regions including lymph nodes (25.4%), bone (24.7%), urinary tract (23.5%), lung (19.4%), liver (18.1%), and brain (3.1%) [4]. Spectral CT is valuable in the detection of distant metastases. It can differentiate between normal abdominal structures and metastatic tissue suggestive of abnormality through material decomposition techniques [5]. The disease has a high risk of recurrence and pathologic biopsy was previously used as the gold standard thus requiring follow-up after initial treatment [6].

In the diagnosis and treatment of cancer, it is necessary to determine the origin of the tumor cells, and it is also necessary to know precisely the location and extent of the tumor as well as its relationship to the surrounding tissues and vascular structures, which are very important for treatment planning. Spectral CT is a new CT modality, which is nowadays more and more widely used in clinical practice, especially in tumor diagnosis. It provides quantitative parameters based on the analysis of material composition and can magnify small differences within tissues [7]. Here, we present a very rare case of bladder urothelial carcinoma with gastric metastasis, which was diagnosed by determining the homology of the two lesions by spectral CT.

Case presentation

A 51-year-old female patient presented with pain in the lower abdomen and lower back more than 2 months. The patient underwent transurethral ureteroscopic lithotripsy for kidney stones at a local hospital two months ago. A ureteral stent was placed during the procedure and removed one month later. During the course of the illness, the patient experienced metastatic pain in the lower abdomen, which was colicky and intermittent, without symptoms of hematuria, urinary frequency, urgency, or dysuria. The patient also reported accompanying lumbar and back pain but did not have a fever. Since the onset of the disease, she had a low appetite with nausea and anorexia. The patient had no history of chronic diseases and no regular medication use. Additionally, the patient had no family history of cancer.

Physical examination: both kidneys were positive for percussion pain. Laboratory test: hemoglobin 129g/L, alkaline phosphatase 41.7U/L, creatine kinase 32U/L, carcinoembryonic antigen 7.88 ng/mL, cancer antigen 125 536.00 U/mL, cancer antigen 153 48.90 U/mL; fecal routine showed positive for occult blood; There were no obvious abnormalities in blood routine, urine analysis, coagulation function and electrocardiogram.

CT urography showed local thickening and delayed enhancement of the right wall of the bladder (Fig. 1A), and delayed enhancement of soft tissue density nodules with clear borders in the left adnexal area (Fig. 1B). Magnetic resonance (MR) showed thickening of the right wall of the bladder with low signal on T1WI, high signal on T2WI, and limited diffusion in diffusion weighted imaging (DWI) (Fig. 1C-F). Solid nodules in the left adnexal area (Fig. 1D), restricted diffusion in DWI (Fig. 1G, 1). Pathological indicated invasive urothelial carcinoma after cystoscopy biopsy (cT3N+M1b IVB) (Fig. 1I, J).

Electronic gastroscopy suggested that bile reflux gastritis and multiple protruding nodules with erosion in the gastric body and gastric antrum (Fig. 2A, B). Pathological examination of gastric protuberant lesions showed metastatic urothelial cell carcinoma (Fig. 2C, D).

Regarding the spectral CT protocol, we used a spectral CT system to perform all examinations, covering the entire abdomen. We utilized 40 keV, close to the k-edge of iodine, to enhance contrast between the bladder tumor and normal tissue, and acquired venous phase images [8]. During spectral CT, the stomach was well distended. Image evaluation was performed by a radiologist with extensive experience in abdominal imaging. Conventional spectral quantitative analysis was used to select the solid component of the largest layer of the lesion in the axial image, and different regions of interest (ROI) were delineated according to the lesions. The ROIs were placed in areas with uniform tumor density as much as possible, avoiding the tumor edge, bleeding, and necrotic areas [9]. The dimensions of the bladder tumor measured by spectral CT were 11.6 mm×42.2 mm×44.4 mm. We use multiparameter spectral imaging to analyze the multiple lesions of gastric mucosal (S1, S2, S3, and S4), the lesions in the bladder wall (S5) and the left adnexal region (S6). The multiparameter images of energy spectrum not only improved the visualization of lesions, but also could be used for homology identification. The following imaging parameters were acquired through multiparameter spectral imaging: iodine concentration and effective atomic numbers. Both iodine concentration and effective atomic numbers are considered surrogate measures for tumor vascularity and perfusion. While iodine concentration directly quantifies iodine content, the effective atomic number describes the average atomic number of a tissue of interest and can thus indirectly provide information about the accumulation of contrast material. Iodine concentrations were used to distinguish urothelial tumors from lesions of other histologic origins [10–12]. The slope value of spectral curve showed the gastric lesions (S1, S2, S3 and S4) and the bladder wall lesions (S5) had similar slope values, and the shape of spectral curve was basically the same, which was considered to be homologous (Fig. 2J-O, Table 1). These results provided an important reference

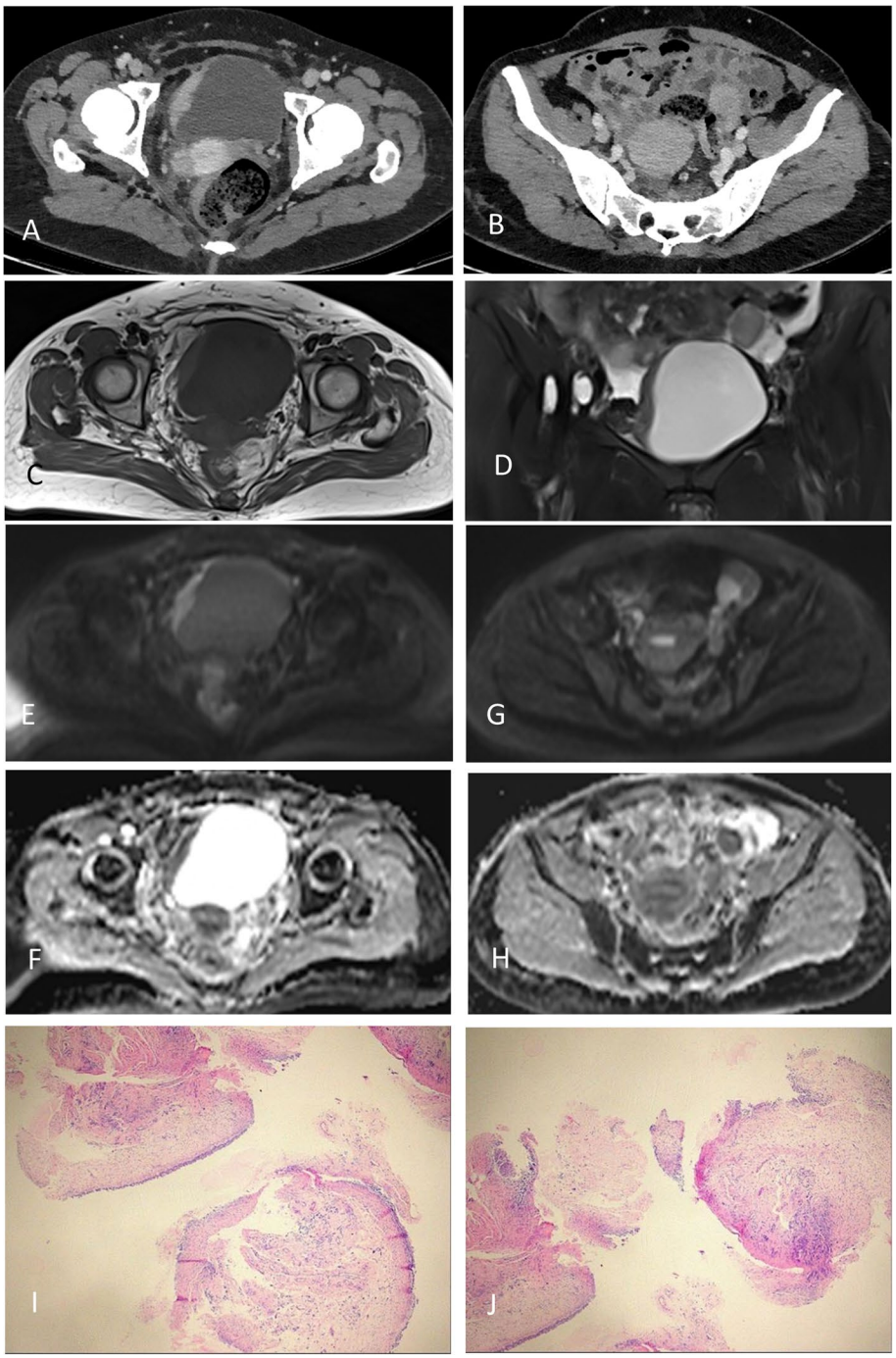

Fig. 1 CT urography showed local thickening and delayed enhancement of the right wall of the bladder (**A**), and mildly enhancing nodule in the left adnexal area (**B**). Pelvic MR showed localized thickening of the right lateral wall of the bladder with low signal on T1WI (**C**), high signal on T2WI (**D**), and limited diffusion in DWI (**E**, **F**). Solid nodules in the left adnexal area with slightly higher signal on T2WI (Fig. 1D), restricted diffusion in DWI (**G**, **H**). The pathological results of cystoscopy biopsy showed that (**I**, **J**) the surface of the tissue was covered with transitional epithelial cell, fibrous tissue hyperplasia in the lamina propria of the mucosa. Atypical cells were seen in the tissue, these cells had a small volume with ovoid nuclei and basophilic cytoplasm, and were arranged in nests, sheets, and diffusely

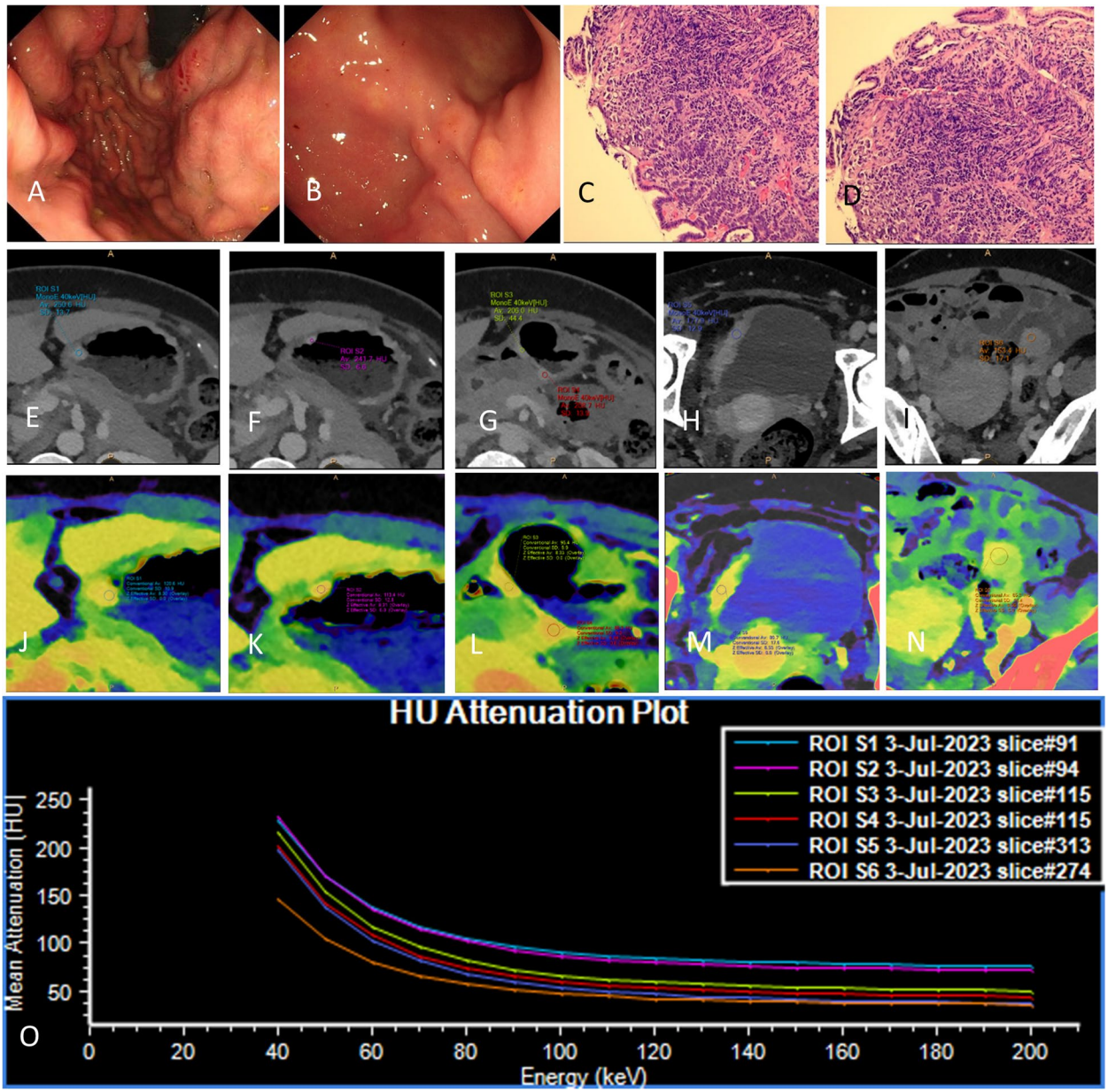

Fig. 2 Electronic gastroscopy (**A**, **B**) showed that the gastric mucosa was congested and swollen with obvious thickening, coarse folds, multiple protruding nodules with central depression in the gastric body and gastric antrum, and yellow staining of the mucus lake. Pathological findings of gastric wall protrusion lesions showed that there were heterotypic cells in the mucosa, which were arranged in the shape of a rope with infiltrating growth (**C**, **D**). 40 keV single energy pseudocolor images of S1, S2, S3, S4, S5 and S6 lesions (**E**-**I**). The effective atomic number map showed that the effective atomic number values of S1-S4 lesions in gastric wall were basically the same as those of S5 lesions in bladder wall (**J**-**N**). The spectral curves showed that the lines of S1, S2, S3, S4 and S5 curves were basically parallel, indicating that the gastric lesions and bladder wall lesions were homologous(**O**)

for the diagnosis of bladder cancer with synchronous urinary tract epithelial gastric metastasis. However, there were significant differences in multiple spectral parameters between the lesions in the left adnexal area and the gastric and bladder walls (S6, Table 1), the spectral curves were also inconsistent, which was considered to be non-homologous (Fig. 2O).

After the multidisciplinary team, we concluded that surgery was not feasible and recommended anti-tumor therapy. According to the treatment plan, we administered six cycles of the GP regimen chemotherapy:

Table 1 CT parameter values of each ROI energy spectrum

Venous phase	Conventional image -CT value	Monoenergetic 40 keV-CT value	Iodine concentrations	Effective atomic numbers	Slope value of the spectral curve
Gastric lesion S1	120.6 HU	236.0 HU	1.92 mg/ml	8.30	3.812
Gastric lesion S2	113.4 HU	230.0HU	1.91 mg/ml	8.31	3.867
Gastric lesion S3	95.4 HU	208.7 HU	1.92mg/ml	8.33	3.816
Gastric lesion S4	88.3 HU	212.5 HU	2.05mg/ml	8.39	4.069
Bladder lesion S5	80.7HU	195.8 HU	1.90 mg/ml	8.33	3.770
Left adnexal lesion S6	65.3 HU	143.8HU	1.31 mg/ml	8.06	2.617

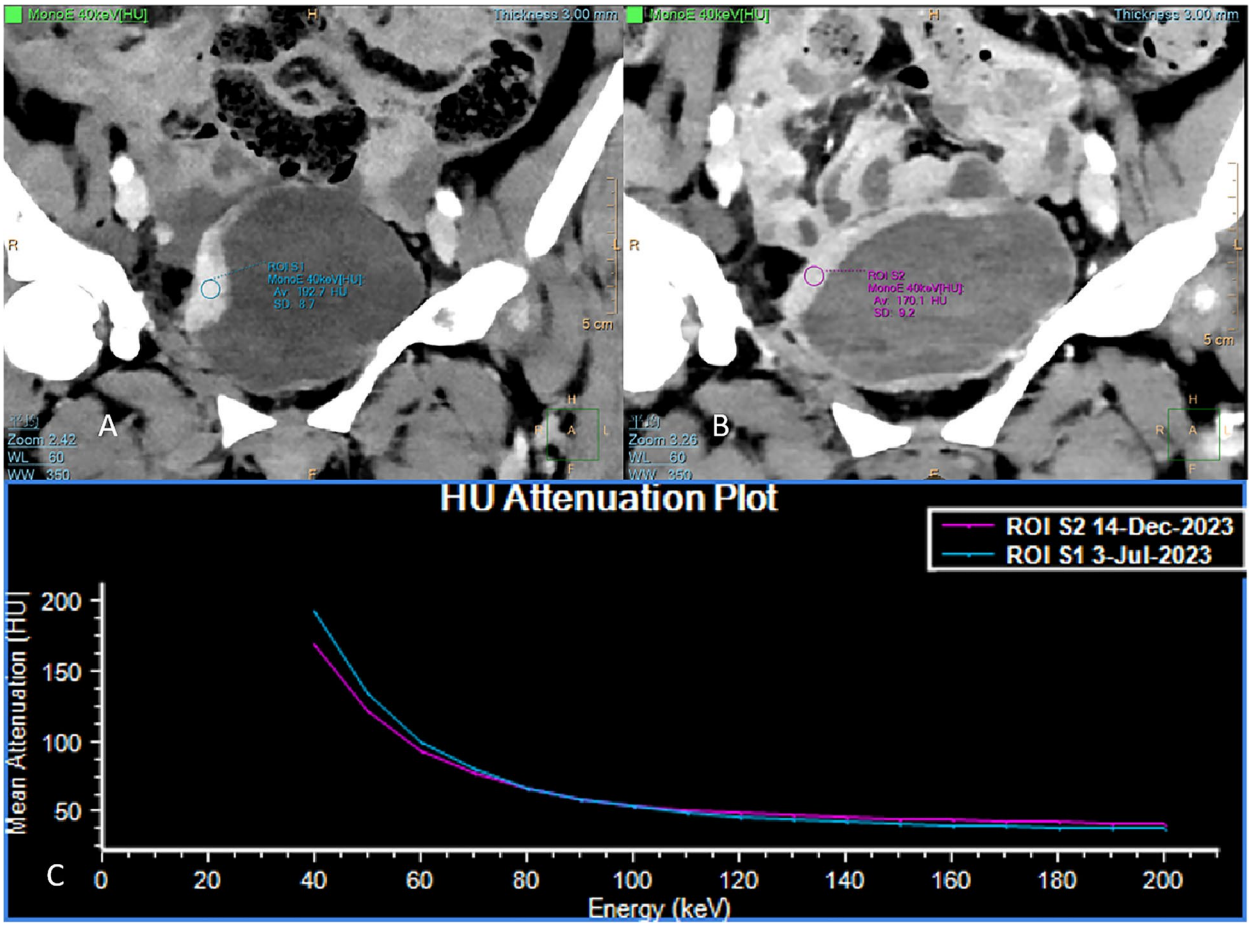

Fig. 3 Initial (**A**) and follow-up (**B**, after 5 months) spectral CT of bladder wall lesions in venous phase (40 keV). The spectral curves (**C**) of initial and follow-up spectral CT of bladder wall lesions

gemcitabine (1 g/m^2) via intravenous infusion on days 1 and 8, and cisplatin (40 mg) via intravenous infusion on days 1 to 3. The treatment proceeded smoothly. After 5 months, the patient underwent spectral CT examination and found that the initial and follow-up examination CT values of bladder wall lesions in venous phase (40 keV) were 192.7HU and 170.1HU, respectively (Fig. 3A and B). Slope values of the spectral curve were 3.74 and 3.09 in the initial and follow-up spectral CT(Fig. 3C). The inconsistent slope value of the spectral curve indicated a change in the histological characteristics of bladder lesions. And the protruding lesions of the gastric wall had disappeared.

Discussion

Bladder cancer is the most common malignant tumor in the urinary system, and its prognosis largely depends on tumor stage and pathological features. Urothelial carcinoma is the most common pathological type of bladder cancer, accounting for about 90% [13]. At the time of diagnosis, metastatic disease is present in approximately 4% of urothelial carcinoma of the bladder cases. And metastatic disease is one of the most important factors contributing to poor patient prognosis [14]. The most common sites of metastasis are lymph nodes, bone, urinary tract, lung, liver, and brain [4]. Urothelial carcinoma is at high risk of recurrence and requires urine cytology, cystoscopy, and CT urography follow-up after initial treatment. Urine cytology showed high sensitivity in high-grade urothelial carcinoma and carcinoma in situ, but low sensitivity and limited reliability in low-grade urothelial carcinoma. Cystoscopy is an invasive examination, multiple examinations may cause complications such as inflammation, and the follow-up cost is high. Imaging can not only stage bladder cancer before surgery, but also evaluate the relationship between tumor tissue, surrounding tissue and vascular structure, as well as distant metastasis, which is widely used in clinical practice [6].

The present case is a very rare case of bladder cancer with synchronous urinary tract epithelial gastric metastasis. We applied multi-parameter quantitative indicators of spectral CT to more accurately show the homology characteristics of gastric metastasis and bladder cancer, and also reflected the different sources of cystic lesions in the left adnexal region from bladder cancer and gastric metastasis. Finally, multiple protruding lesions on the gastric wall were confirmed by pathology as metastatic urothelial carcinoma. Pathological biopsy is the gold standard in the diagnosis of gastric metastasis of urothelial carcinoma, and this case provides important clinical application value for the non-invasive quantitative diagnosis of metastatic lesions by spectral CT in the future. Through regular chemotherapy, the gastric wall lesions disappeared after 5 months, and the slope of the spectral curve of the lesion on the right side of the bladder was significantly different from that before treatment. This result indicates that the histological characteristics of the bladder lesion have changed. The tumor is effectively treated after chemotherapy.

Wymer et al. [14] reported an 82-year-old case of gastric metastasis from urothelial carcinoma, which was only confirmed by CT enhancement, pathological HE staining and immunohistochemistry. As a non-invasive method, spectral CT has a promising application prospect in detecting the homology of different lesions and diagnosing bladder cancer with synchronous urinary tract epithelial gastric metastasis. Its multi-parameter images can not only improve the detection rate of lesions and enhance the visualization of lesions [15], but also make use of multi-parameter information to compare the lesions in the stomach wall, adnexal area and bladder wall of patients, providing a new non-invasive quantitative method for clinicians to accurately diagnose the nature of tumors and multiple metastases in the future. In solid kidney and urothelial lesions, the presence of vessels within them can indicate enhancement after contrast medium administration, reflecting the presence of iodine in postprocessing. Therefore, spectral CT and its derived images can be utilized to evaluate and differentiate renal and urothelial lesions [16–18]. Große et al. [19] demonstrated that spectral CT can also be used to differentiate renal stones through semiautomated volumetric segmentation and image postprocessing for the determination of a spectral coefficient. However, the number of cases of urothelial bladder carcinoma in our study is small. The data obtained are only for this case and did not have statistical significance, which could not be used for qualitative assessment of gastric metastasis of urothelial bladder carcinoma. We need further in-depth research to confirm this subsequently. This is the limitation of our research.

Conclusion

In conclusion, currently, for the diagnosis of urothelial carcinoma of the bladder, clinicians primarily rely on cystoscopy as the gold standard. However, this approach is unfavorable for patient prognosis and progression, and it cannot determine whether an abnormal lesion is metastatic. The multiparametric images obtained from spectral CT not only improve tumor visualization but also provide quantitative analyses and achieve the homologous identification of different lesions. This provides new insights and possibilities for the future noninvasive diagnosis of bladder urothelial carcinoma and its metastatic lesions.

Abbreviations

CT	computed tomography
ROI	region of interest
MR	magnetic resonance
DWI	diffusion weighted imaging

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Clinical trial number
Not applicable since it is a case report.

Authors' contributions
GW and LLW: co-first author; GW: corresponding author; GW and LLW wrote the main manuscript text; DDD and HXX prepared Figs. 1, 2, 3 and Table 1 ; SHY and YW reviewed the manuscript.

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Data availability
All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate
This study has been approved by Ethics Committee of the First Hospital of Lanzhou University (Approval number: LDYYLL2022-251).
Informed consent was obtained from all individual participants included in the study.

Consent for publication
Written informed consent was obtained from the patient for the publication of any potentially identifiable images or data included in this article.

Competing interests
The authors declare no competing interests.

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