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Magnetic resonance imaging of bladder pheochromocytoma: A case report

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► *Case Report*

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ABSTRACT

Bladder pheochromocytoma, as a rare bladder tumor, which originated from the chromaffin tissue of the sympathetic nervous system. It is difficult to distinguish from other non-epithelial tumors on imaging. This study reported a 31-year-old female, whose physical examination revealed a bladder mass for 50 days. The patient's main clinical symptoms included sudden headache, dizziness, increased blood pressure, and chest palpitations after intermittent micturition. However, laboratory tests showed that the 24-hour urine catecholamine levels (norepinephrine, vanillylmandelic acid [VMA] and metanephrine) were normal. Magnetic resonance imaging (MRI) showed a mass in the posterior bladder wall, the typical performance is"light-bulb" bright lesion on T2-weighted imaging. The mass was surgically excised, and histopathological examination revealed that it was a pheochromocytoma. During the first 3-month of postoperative follow-up, the patient's symptoms gradually subsided. To our knowledge, this is the first case reporting on the use of MRI imaging and specific image features of this rare bladder pheochromocytoma. Due to the better soft tissue resolution and multi-parameter on MRI, changes in the size and internal signal of the lesion can be clearly displayed. Thus, MRI is an indispensable tool in tumor diagnosis and prognosis assessment.

INTRODUCTION

Pheochromocytoma is a neuroendocrinal tumor that arises from the chromaffin tissue of the adrenal medulla and sympathetic ganglion [(1)]. Pheochromocytomas can occur anywhere from the skull to the bladder, and around 10% arise from extra-adrenal organs, where they are known as paragangliomas [(2)]. Bladder pheochromocytoma arises from the chromaffin tissue of the sympathetic nervous system and is associated with the bladder wall [(3)]. It accounts for less than 0.06% of all bladder tumors and less than 1% of all pheochromocytomas [(4)]. Typical clinical symptoms reported in literature include hematuria, hypertension, headache, sweating, and tachycardia provoked by micturition or bladder overdistention [(4)]. At present, most literature report on its clinical manifestations and treatment methods; however, there are relatively few reports on the image performance of bladder pheochromocytoma, and the computed tomography (CT) examination cannot be accurately qualitative for non-functioning tumors. This study was to report a case of bladder pheochromocytoma and the role that magnetic resonance imaging (MRI) could play in its diagnosis. It highlighted the necessity of using MRI to improve the recognition and diagnosis of this disease.

Case report

A 31-year-old female had a physical examination, which revealed a bladder mass for 50 days. At the time of admission into the hospital, she reported episodic palpitation, tachycardia, and profuse post-micturition sweating, which were separated by periods of time where she was asymptomatic. Tumor markers such as carcinoembryonic antigen and carbohydrate antigen (CA) 199 were all within the normal ranges. Laboratory evaluations such as 24-hour urinary catecholamine levels (norepinephrine, vanillylmandelic acid [VMA], and metanephrine) were normal.

The MRI findings of the patient were shown in figure 1. MRI revealed a small round mass (1.0×1.0×0.85 cm^3) within the posterior bladder wall. The mass showed hyperintensity of uniformity on T1-weighted imaging (T1WI), and high-signal intensity on T2-weighted imaging (T2WI) and fat-saturated T2-weighted imaging (FS-T2WI) (figure 1A-C). There

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was a high signal on diffusion weighted images (DWI) (figure 1D), but low signal on the apparent diffusion coefficient (ADC) image (figure 1E). After injection of gadolinium-contrast, dynamic enhanced scan demonstrated homogeneous enhancement in arterial phase, and progressive enhancement in portal vein phase and delayed phases (figure 1F-I). This mass, located in the posterior upper wall of the bladder, had a regular shape and was clearly demarcated from the adjacent bladder wall. The lesion showed hyperintensity of uniformity on T2WI and demonstrated homogeneous enhancement in all stages. However, other diseases rarely show similar imaging performance. Overall, the MRI features were highly suggestive of the tumor being typed as a bladder pheochromocytoma, therefore demonstrating its value as a diagnostic tool for pheochromocytomas.

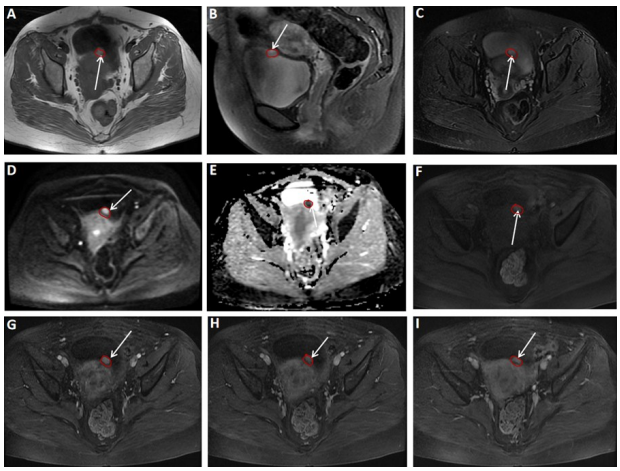


Figure 1. Magnetic resonance imaging of a bladder pheochromocytoma. Axial and coronal sections from magnetic resonance imaging (MRI). **(A)** MRI revealed a small round hyperintense mass within the posterior bladder wall on axial T1WI; **(B-C)** The mass with high signal on coronal T2WI and axial fat-saturated T2WI; **(D)** The mass was hyperintense on DWI; **(E)** The ADC image with low signal; **(F)** The mask image shows a high signal before using the contrast agent; **(H-I)** Enhanced MRI showed homogeneous enhancement on artery phase and progressive enhancement on portal and delayed phase.

This patient underwent transurethral resection of the bladder tumor (TURBT). Intraoperatively, her blood pressure was elevated at 170/90 mmHg during excision at the base of the tumor, but decreased to the normal range upon total removal of the tumor. The specimen was visible to the naked eye, and had a complete envelope with abundant blood supply. Pathological examination of the tumor confirmed the MRI diagnosis of bladder pheochromocytoma. The tumor tissue was divided into numerous small nests, composing of polygonal, fusiform tumor cells surrounded by blood sinuses and fibrous stroma (figure 2A). Immunohistochemistry analysis showed that the tumor cells were positive for Chromaffin granule A (CgA) (figure 2B), Synaptophysin(Syn) (figure 2C), but negative for Inhibin-α, Cytokeratin (CK), Epithelial membrane antigen(EMA) and Melan-A.

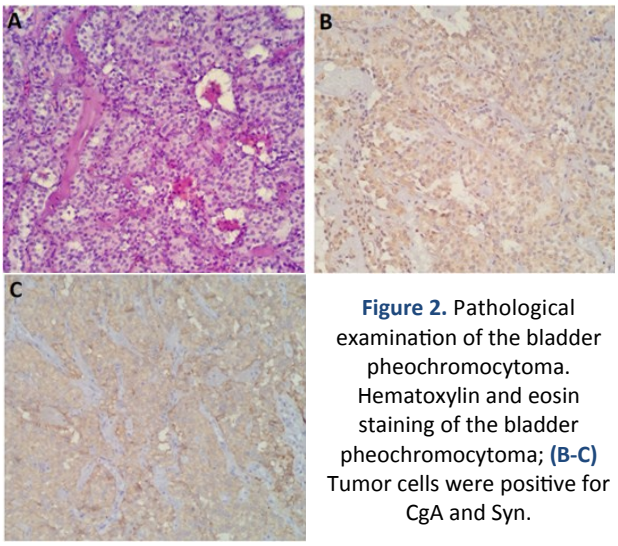


Figure 2. Pathological examination of the bladder pheochromocytoma. Hematoxylin and eosin staining of the bladder pheochromocytoma; **(B-C)** Tumor cells were positive for CgA and Syn.

DISCUSSION

In 1953, the first case of urinary bladder pheochromocytoma was reported by Zimmerman [5]. As a non-epithelial tumor, bladder pheochromocytoma accounts for < 1% of all pheochromocytomas and <0.06% of all bladder tumors [4]. The peak incidence of this disease is around 30-40 years old and can occur at any age, and there is no difference between male and female. The disease often occurs in the triangular area of the bladder and the posterior parietal wall, followed by the lateral wall. Functional bladder pheochromocytoma usually presents with symptoms of hematuria and hypertension, along with those associated with elevated catecholamines such as headache, syncope, and palpitations, which are usually provoked by micturition or overdistention of the bladder [6].

Vanillylmandelic acid is the most effective biochemical marker for diagnosing pheochromocytoma. However, 27% of bladder pheochromocytomas do not feature any hormonal activity [7], and some patients have no typical clinical manifestations, making qualitative diagnosis before surgery difficult. Therefore, imaging findings can provide important additional diagnostic evidence. Most bladder pheochromocytomas have the following characteristics on MRI, the lesions are located in the submucous and muscular layers, so the mucosa inside the tumor is smooth, continuous and complete; The shape of the tumor is round or oval and the size of the lesion varies; The tumor has a relatively complete capsule and a clear boundary; There was no abnormal thickening of the bladder wall adjacent to

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the tumor; The classic imaging characteristic of pheochromocytomas is a "light-bulb" bright lesion on T2WI, and which usually presents isosignal and hyposignal on T1WI, but their appearance on T1WI and T2WI are quite variable if necrosis or hemorrhage is present [8]. Contrast-enhanced MRI shows obvious uniform enhancement, but the enhancement is variable, which depending on the degree of cystic necrosis.

Differential diagnosis based on MRI findings included the following diseases. The shape, location, and MRI features of the tumor may help in the differential diagnosis, but a definitive diagnosis requires histopathological evaluation. Table 1 summarizes the MRI imaging features of various tumors:

***Bladder cancer*:** The most common malignant tumor. On T1WI MRI imaging, bladder wall and tumor show intermediate signal intensity, whereas on T2WI, the tumor shows intermediate to high signal intensity [9]. It appears hypointense on ADC images, but hyperintense on DWI. In addition, contrast-enhanced MRI demonstrates homogeneous enhancement in the artery phase.

***Bladder leiomyoma*:** Typical leiomyomas are homogeneous and almost isointense on T1WI and T2WI MRI imaging, with a smooth surface, indicating pathological characteristics of abundant muscle or fibrous tissue [10]. On contrast-enhanced MRI, some leiomyomas show homogeneous enhancement, while others have heterozygous intensities, due to degeneration or necrosis of the tumor.

***Inflammatory myo-fibroblastic tumor (IMT)*:** Most IMT lesions show irregular soft tissue masses, which are either isointense to hypointense on T1WI, as well as demonstrating a heterogeneously high signal on T2WI MRI images. On the other hand, contrast-enhanced MRI depicts the lesions having homogeneous enhancement [11]. It is similar to bladder pheochromocytoma on MRI performance. So pathological diagnosis is needed to distinguish the two.

***Bladder solitary fibroma tumor (SFT)*:** The urinary bladder is an unusual location for solitary fibrous tumors. On MRI, SFT exhibits low signal on T1WI, and heterogeneous, high or low intensities on T2WI. Lines can also be clearly seen on T2WI in an irregular interlacing pattern, which is termed as "geographical appearance", Enhanced scanning shows that heterogeneous enhancement in arterial phase, continuous enhancement in the venous phase and delayed phase [12].

Table 1. Summarizes the MRI imaging features of various tumors.

Bladder tumor type	Tumor morphology and boundary	Tumor imaging performance on MRI	Tumor adjacent structure and organs
Bladder pheochromocytoma	Round or oval; A relatively complete capsule; A clear boundary;	Isointense and hypointense on T1WI; Hyperintense on T2WI; Homogeneous enhancement;	No abnormal thickening of the bladder wall adjacent; No invasion of adjacent organs;
Bladder cancer	Irregular shape, like cauliflower or nodular; Without a relatively complete capsule;	Isointense on T1WI; Isointense to hyperintense on T2WI; Hyperintense on DWI; Homogeneous enhancement;	Irregular thickening of the adjacent bladder wall; Invasion of adjacent organs;
Bladder leiomyoma	Round, oval or lobular; A smooth surface;	Homogeneous isointense on T1WI and T2WI; Homogeneous or mild to moderate enhancement;	No thickening of the bladder wall adjacent; No invasion of adjacent organs;
Inflammatory myo-fibroblastic tumor(IMT)	Single lobular or irregular mass; A clear boundary;	Isointense to hypointense on T1WI; Heterogeneously hyperintense on T2WI; Homogeneous enhancement;	No thickening of the bladder wall adjacent; Similar MRI performance with bladder pheochromocytoma;
Bladder solitary fibroma tumor (SFT)	An irregular mass; Large tumor size; A smooth surface;	Low signal intensity on T1WI; Heterogeneous, high or low intensities on T2WI; Heterogeneous, continuous and delayed enhancement;	No thickening of the bladder wall adjacent; No invasion of adjacent organs;

The treatments for bladder pheochromocytoma are diverse, including TURBT, open partial cystectomy, laparoscopic partial cystectomy, and robot-assisted laparoscopic partial cystectomy [13]; safe surgery requires adequate anesthetic preparation. Due to malignancy being present in approximately 10% of all extra adrenal pheochromocytomas [7], it can be challenging to treat the disease. In addition to surgery, adjuvant therapy such as chemoradiotherapy and radionuclide therapy also is an effective treatment for pheochromocytoma patients [14]. Approximately 50% of patients with malignant pheochromocytoma are found to carry hereditary germline mutations in the succinate dehydrogenase subunit B gene, facilitating the use of molecule-targeting drugs in treating some malignant cases [15]. Regular follow-up and review are needed after surgery.

In conclusion, the diagnosis of bladder pheochromocytoma is confirmed by combining specific symptoms, laboratory examination, and image characteristics [16]. MRI showed specific characteristics of bladder pheochromocytoma, making it a valuable tool in assisting diagnosis of this disease. This is the first case reporting on the use of MRI imaging for the diagnosis of the rare form of bladder cancer.

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***Contributors*:** LW, collected the case. DQ, and LW, reviewed the literature and contributed to drafting the manuscript. JL acquired data. JD and QQ performed the MRI imaging analysis. HY and QD performed the pathological analysis and offered the conception of the work. HZ revised the manuscript to be submitted.

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