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LETTER TO THE EDITOR

MRI feature analysis of uncommon prostatic malignant tumors

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Dear Editor,

Most prostatic neoplasms are epithelial in origin. Non-epithelial prostatic neoplasms are quite rare, but they cover a broad array of types that include neuroendocrine tumors, mesenchymal tumors, hematolymphoid tumors, miscellaneous tumors, etc. Unlike prostate cancer, there is no specific serum marker for non-epithelial prostatic neoplasms at present, and the majority of patients present with a large pelvic mass and compressive symptoms of dysuria or abdominal pain. Imaging plays an important role in the investigation of prostate masses, although transrectal ultrasound-guided prostate biopsy remains the gold standard for diagnosis. Magnetic resonance imaging (MRI) contributes to determining the site of origin of the tumor, local extent, and signal characteristics owing to its high soft-tissue contrast resolution. Many studies have demonstrated that MRI characteristics can help predict histological types of tumors, which can guide clinical treatment. As there is a low morbidity rate for uncommon prostatic neoplasms, MRI features have rarely been described in the literature and they are mainly reported as case reports. In this letter, we retrospectively reviewed the MRI features of 15 cases of uncommon prostatic malignant tumors, which, to our knowledge, is the largest number of these tumors reported to assess MRI features. As accurate diagnosis is critical for appropriate clinical workup and management, the aim of this study was to explore some salient MRI characteristics of uncommon prostatic malignant tumors to improve understanding and facilitate the differential diagnosis.

This retrospective study was approved by Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology Institutional Review Board. We collected the clinical data of 15 cases of uncommon prostatic tumor patients from January 1, 2011, to December 31, 2015, in Tongji Hospital. And informed consents were obtained from all patients. The age range was from 22 years to 69 years, with a median age of 46 years. Nine cases presented with dysuria, two cases had lower abdominal pain, two cases were accidentally discovered on routine physical examination, one case had dyschezia as well as fresh blood in the feces, and one case had waist pain as well as perineal pain. The median value of the serum prostate-specific antigen (PSA) was 1.412 (range: 0.435–126.634) ng ml\(^{-1}\). The pathological study was performed via transrectal ultrasound-guided biopsy in 11 patients, transurethral resection of the prostate in one patient, and open surgery in three patients. The final pathological diagnoses were embryonal rhabdomyosarcoma (RMS) in two patients, prostatic stromal sarcoma (PSS) in four, mesenchymal tumors not otherwise specified in four, small cell carcinoma (SCC) in three, and lymphoma in two. All the patients underwent conventional MRI including T1-weighted imaging (T1WI) and T2-weighted imaging (T2WI), nine patients underwent diffusion-weighted imaging (DWI), and ten patients underwent dynamic contrast-enhanced (DCE) MRI. The clinical characteristics and MRI findings are shown in Table 1. The detailed clinical, immunohistochemical, and MRI information are shown in Table 1. Tumors were round, and irregular, and irregularly shaped. Eleven tumors occupied the entire prostate, with loss of the normal zonal anatomy on T2-weighted images. Four tumors occupied the majority of the prostate. Among the nine patients who had DWI examinations, all tumors showed high signal and the apparent diffusion coefficient value was relatively low. A typical case of embryonal rhabdomyosarcoma is shown in Figure 1. The tumor presented with a well-defined T2 low signal pseudocapsule with internal cystic degeneration, bleeding, large necrotic areas and exerted a significant mass effect on bladder and rectum.

For the ten prostatic malignant mesenchymal tumors, tumors had low signals mixed with patchy high signals in five patients and were isointense in five patients on T1WI. Most prostate sarcomas had heterogeneous signal intensity on T2WI, which was consistent with multiple cysts in eight patients, hemorrhagic necrosis in seven patients as well as marked heterogeneous enhancement in six patients after the administration of contrast agents. Most of the prostate sarcomas presented with a well-defined T2 low signal pseudocapsule and exerted a significant mass effect on adjacent structures, such as bladder in five patients and rectum in five patients. There was evidence of adjacent invasion of the seminal vesicle in eight patients, bladder in two patients, and rectum in three patients. There was evidence of distant metastatic spread in two patients and liver metastasis in one case. For the three small-cell carcinomas, T2WI showed a large heterogeneous prostatic mass and the prostate capsule was incomplete. The lesions were isointense on T1WI and mildly hyperintense on T2WI. The lesions showed mild or moderate heterogeneous enhancement after the administration of a contrast agent. Some cases showed invasion of adjacent structures, which showed involvement of the seminal vesicle in three patients, bladder in three patients, and rectum in two patients. Pelvic lymph node metastasis was present in one case. There was evidence of distant metastasis in one case (liver case) and two cases (bone cases). For the two B-cell non-Hodgkin lymphomas, one case was predominantly in the prostate.
and one case extended to adjacent tissues. The tumors were found to be homogeneously isointense on T1WI and homogeneously isointense on T2WI. Both cases underwent dynamic contrast-enhanced scans and demonstrated moderate and homogeneous enhancement. All of the cases had nodal involvement. One case showed multiple enlarged pelvis and retroperitoneal nodes. Adjacent involvement included the seminal vesicle \((n = 2)\), bladder \((n = 2)\), and rectum \((n = 1)\). There was no clinical or radiologic evidence of distant metastasis in any patients.

Noninvasive multiparametric MRI provides comprehensive information that is needed for preoperative diagnosis and evaluation of prostate neoplasms. By combining the clinical finding and imaging, it is possible to primarily differentiate the histologic subtypes of prostate neoplasms. First, it is essential to distinguish uncommon prostatic malignant tumors from prostate adenocarcinoma because of their differences in management and prognoses. Prostate cancer tends to occur at an older age after 50 years, while some malignant mesenchymal tumors such as RMS are more common in children and young adults. Most prostate cancer cases are asymptomatic and are detected by PSA screening. However, the uncommon prostatic malignant tumors including RMS, stromal tumors, and lymphomas are presented with obstructive urinary symptoms and total serum PSA levels in the normal range. On MRI, most malignant tumors, such as RMS and PSS, demonstrate a well-defined and low signal intensity pseudocapsule. Cystic components are visualized. In contrast to the mesenchymal tumors, neuroendocrine SCC is characterized by regional nodal invasion, adjacent involvement, and distant metastasis. Hemorrhage and necrosis are very common because of high malignancy and rapid growth and there is no pseudocapsule. Serum neuron-specific enolase values and serum PSA is always elevated.

In conclusion, we found some differences among RMS, PSS, SCC, and lymphoma, although there was some overlap in the MR imaging findings. Combined with clinical and laboratory indicators, MRI can provide a credible preoperative diagnosis, avoiding the provision of unnecessary clinical testing or therapies to patients.

Table 1: The clinical characteristics and magnetic resonance imaging findings

| Number of patients | Age (year) | Histology                        | PSA (ng ml⁻¹) | Shape | T2WI | T1WI | DWI | Pseudocapsule | Cystic change | Necrosis | Adjacent invasion                                      |
|--------------------|------------|----------------------------------|----------------|-------|------|------|-----|---------------|--------------|----------|-------------------------------------------------------|
| 1                  | 43         | Embryonal rhabdomyosarcoma       | 0.655          | Irregular | Hyper | Iso | Hyper | Present | Present | Seminal vesicle invasion, bladder and rectal compression |
| 2                  | 22         | Embryonal rhabdomyosarcoma       | 1.668          | Lobular | Hyper | Iso | Hyper | Present | Present | Involving the penis and the right obturator muscle, bladder compression, seminal vesicle intact |
| 3                  | 25         | Stromal sarcoma                  | 0.471          | Lobular | Hyper | Iso | Hyper | Present | Present | Seminal vesicle invasion, bladder and rectal compression |
| 4                  | 64         | Stromal sarcoma                  | 1.937          | Lobular | Hyper | Iso | -    | Present | Present | Seminal vesicle invasion, bladder and rectal compression |
| 5                  | 45         | Stromal sarcoma                  | 2.500          | Round   | Hyper | Iso | -    | Present | Present | Seminal vesicle invasion, rectal compression |
| 6                  | 67         | Stromal sarcoma                  | 0.970          | Lobular | Hyper | Iso | -    | Present | Present | Seminal vesicle invasion, rectal compression |
| 7                  | 46         | Malignant mesenchymal tumors     | 0.435          | Irregular | Hyper | Iso | -    | Present | Present | Seminal vesicle invasion, retroperitoneal nodes metastatic |
| 8                  | 43         | Malignant mesenchymal tumors     | 1.020          | Lobular | Hyper | Iso | -    | Present | Present | Seminal vesicle invasion |
| 9                  | 25         | Low-grade sarcoma                | 2.630          | Irregular | Hyper | Hypo | Hyper | Present | Present | Seminal vesicle, rectal and bladder invasion |
| 10                 | 34         | Spindle cell sarcoma             | 1.412          | Lobular | Hyper | Iso | Hyper | Present | Present | Seminal vesicle invasion, bladder compression, rectal invasion |
| 11                 | 63         | Small cell carcinoma             | 5.600          | Round   | Hyper | Hypo | Hyper | Absent  | Present | Seminal vesicle and bladder invasion |
| 12                 | 69         | Small cell carcinoma             | 3.140          | Irregular | Hyper | Hypo | Hyper | Absent  | Present | Seminal vesicle, rectal and bladder invasion |
| 13                 | 64         | Small cell carcinoma             | 126.634        | Irregular | Hyper | Iso | Hyper | Absent  | Present | Seminal vesicle and bladder invasion, pelvis lymph node metastasis, rectal invasion |
| 14                 | 50         | Diffuse large B-cell lymphoma     | 0.522          | Irregular | Iso | Iso | Hyper | Absent  | Absent  | Seminal vesicle, rectal and bladder invasion, pelvis lymph node metastasis |
| 15                 | 57         | Follicular lymphoma              | 0.839          | Round   | Iso | Iso | Hyper | Absent  | Absent  | Seminal vesicle and bladder invasion, pelvis lymph node metastasis |

MRI: magnetic resonance imaging; PSA: prostate specific antigen; Hyper: hyperintense; Iso: isointense; Hypo: hypointense; - none; T2WI: T2-weighted imaging; T1WI: T1-weighted imaging; DWI: diffusion-weighted imaging.

In conclusion, we found some differences among RMS, PSS, SCC, and lymphoma, although there was some overlap in the MR imaging findings. Combined with clinical and laboratory indicators, MRI can provide a credible preoperative diagnosis, avoiding the provision of unnecessary clinical testing or therapies to patients.

AUTHOR CONTRIBUTIONS
ZYF and LW participated in the study conception and design, data analysis and interpretation, and manuscript drafting. XDM participated in the paper’s discussion. ZK (Zan Ke) and PPZ helped collect the clinical data. LW, BSL, and ZK (Zhen Kang) reviewed and edited the manuscript. All authors read and approved the final manuscript.
COMPETING INTERESTS
All authors declare no competing interests.

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Supplementary information is linked to the online version of the paper on the Asian Journal of Andrology website.

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### Supplementary Table 1: Clinicopathologic characteristics

| Number of patients | Age (year) | Histology                      | PSA (ng ml\(^{-1}\)) | Resenting symptoms                            | Lesion size on MRI (mm) | Pathologic access | MRI examinations |
|--------------------|------------|--------------------------------|-----------------------|------------------------------------------------|------------------------|-------------------|------------------|
| 1                  | 43         | Embryonal rhabdomyosarcoma     | 0.655                 | Dysuria                                        | 99x98x136              | Systematic biopsy | T1WI T2WI DWI    |
| 2                  | 22         | Embryonal rhabdomyosarcoma     | 1.668                 | Dysuria                                        | 61x94x63               | Systematic biopsy | T1WI T2WI DWI DCE |
| 3                  | 47         | Stromal sarcoma                | 0.471                 | Dysuria                                        | 48x35x40               | Open surgery      | T1WI T2WI DWI DCE |
| 4                  | 64         | Stromal sarcoma                | 1.937                 | Dysuria                                        | 105x127x120            | Open surgery      | T1WI T2WI DCE    |
| 5                  | 45         | Stromal sarcoma                | 2.50                  | Dysuria                                        | 72x65x75               | Open surgery      | T1WI T2WI        |
| 6                  | 67         | Stromal sarcoma                | 0.97                  | Dyschezia fresh blood in the feces             | 50x32x72               | Systemic biopsy   | T1WI T2WI        |
| 7                  | 46         | Malignant mesenchymal tumors   | 0.435                 | Lower abdominal pain                           | 110x131x166            | Systemic biopsy   | T1WI T2WI        |
| 8                  | 43         | Malignant mesenchymal tumors   | 1.02                  | None*                                          | 80x70x60               | Systemic biopsy   | T1WI T2WI DCE    |
| 9                  | 25         | Low-grade sarcoma              | 2.630                 | Dysuria                                        | 102x111x138            | Systemic biopsy   | T1WI T2WI DCE    |
| 10                 | 34         | Spindle cell sarcoma           | 1.412                 | Waist pain perineal pain                      | 72x57 and 78x69        | Systemic biopsy   | T1WI T2WI DCE    |
| 11                 | 63         | Small cell carcinoma           | 5.600                 | Dysuria                                        | 41x21x36               | Transurethral resection of the prostate | T1WI T2WI DCE    |
| 12                 | 69         | Small cell carcinoma           | 3.140                 | Dysuria                                        | 72x87x90               | Systemic biopsy   | T1WI T2WI DCE    |
| 13                 | 64         | Small cell carcinoma           | 126.634               | Dysuria                                        | 65x69x77               | Systemic biopsy   | T1WI T2WI DCE    |
| 14                 | 50         | Diffuse large B-cell lymphoma  | 0.522                 | Lower abdominal pain                           | 93x140x103             | Systemic biopsy   | T1WI T2WI DCE    |
| 15                 | 57         | Follicular lymphoma            | 0.839                 | None*                                          | 54x42x56               | Systemic biopsy   | T1WI T2WI DCE    |

*The patient came to the physician for routine physical examination. PSA: prostate specific antigen; MRI: magnetic resonance imaging; T2WI: T2-weighted imaging; T1WI: T1-weighted imaging; DWI: diffusion-weighted imaging; DCE: dynamic contrast-enhanced

### Supplementary Table 2: Detailed immunohistochemistry characteristics

| Number of patients | Positive                                      | Negative                                      |
|--------------------|-----------------------------------------------|-----------------------------------------------|
| 1                  | Myogenin, MyoD1, Ki-67 Li 60%                 | Desmin, CD117, CD34, DOG1, SMA, S-100, Caldesmon, PCK, EMA, CK8/18, CK19 |
| 2                  | Desmin, Myogenin, MyoD1, Ki-67 Li 60%        | PCK, EMA, CK8/18, SMA, Desmin, h-caldesmon, ALK, MyOD1, Myogenin, S-100, HMB45, MelanA, CD34, CD117, DOG1 |
| 3                  | Ki-67 Li 40%-50%                              | SMA, Desmin, S-100, EMA, PCK, MBP             |
| 4                  | CD117, CD34, DOG1, Caldesmon, Ki-67 Li 6%    | SMA, Desmin, S-100, MyD1, Myogenin, PSA, P504S, P63, HMW-CK, ER, PR |
| 5                  | VIM                                            | PSA, P63, HMW-CK, PCK, CK8/18, CK19, CK7, CK5/6, CD34, SMA, Desmin, S-100, CgA, EMA |
| 6                  | CD117, CD34, DOG1, Caldesmon, VIM, Ki-67 Li 10% | ALK, Bcl-6, CD20, CD21, CD30, CD43, CD5, CD56, CD7, CyclinD1, Desmin, GrB, Mum-1, Myod1, PCK, ER, PR, PSA, S-100, Calponin, Caldesmon |
| 7                  | VIM, P504S, Syn(+/-), Ki-67 Li 30%            | PS, P504S, P63, CgA, CK7, CK8/18, EMA, PCK, ALK, Desmin, Myod1, Myogenin, S-100, SMA, LCA |
| 8                  | SMA, CD10                                      | CGA, M, Syn, CgA, CK7, CK8/18, EMA, PCK, ALK, Desmin, Myod1, Myogenin, S-100, SMA, LCA |
| 9                  | VIM, CD99, CD56, Ki-67 Li 10%-20%             | SMA, CD34, DOG1, SMA, Desmin, PCK, EMA, CK8/18, LCA, Myd1 |
| 10                 | VIM, S-100, CD117, Myogenin, Ki-67 Li 50%    | SMA, CD56, TDF-1, Ki-67 Li 85%               |
| 11                 | CgA, Syn, CD56, TDF-1                        | PSA, P504S, SMA, CD117                        |
| 12                 | CD56, Syn, CgA                               | PS, P504S, SMA, CD117                        |
| 13                 | PCK, Syn, CD56, P63 α, Ki-67 Li 80%          | CgA, PSA, CD56, CD79α, CD43, CD10, BCL-2, CD21 |
| 14                 | LCA, VIM, CD20, CD79α, CD43, CD10, BCL-2, CD21 and CD23 (FDCs), Ki-67 Li 5% | CD3, CD5, BCL-6, CyclinD1, PCK, PSA, P504S, Syn, CD56, CgA, CD34, PR, PSA, ER, SMA |
| 15                 | VIM, CD20, PAX-5, LCA, MUM-1, ERG, Ki-67 Li 60% | PKC, CD7, CD56, Syn, HMW-CK, PSA, CD3, CD43, CD30, TdT, ALK1, CD138, S-100, CD34, CD31, Desmin, Myogenin, MPO, PLAP, HMB45, SALL-4, CK8/18 |

CD: cluster of differentiation; DOG-1: discovered on GIST-1; SMA: smooth muscle actin; PCK: pan-cytokeratin; EMA: epithelial membrane antigen; CK: cytokeratin; ALK: anaplastic lymphoma kinase; HMB45: homatropine methybromide 45; MBP: myelin basic protein; VIM: vimentin; PSA: prostate specific antigen; HMW-CK: high molecular weight cytokeratins; ER: estrogen receptor; PR: progesterone receptor; CgA: chromogranin A; syn: synaptophysin; LCA: leucocyte common antigen; bcl-2: B-cell lymphoma-2; PAX-5: the pair box gene 5; MUM-1: multiple myeloma oncogene 1; TTF-1: thyroid transcription factor-1; GATA-3: GATA-blinding protein-3; TdT: terminal deoxynucotidyl transferase; MPO: myeloperoxidase; SALL-4: sal-like protein 4; ERG: erythroblast transformation-specific-related gene; GrB: growth factor receptor-bound protein; PLAP: placental alkaline phosphatase
Supplementary Table 3: Magnetic resonance imaging findings

| Number of patients | Shape | T2  | T1  | DWI  | Enhancement | Pseudo-capsule | Cystic change | Necrosis | Adjacent invasion | Metastasis |
|--------------------|-------|-----|-----|------|-------------|----------------|---------------|----------|-------------------|------------|
|                    |       |     |     |      |             |                |               |          |                   |            |
| 1                  | Irregular | Hyper | Iso | Hyper | - | Present | Present | Present | Seminal vesical, bladder, and rectal compression | No | No | No |
| 2                  | Lobular | Hyper | Iso | Hyper | Heterogeneous | Present | Present | Involving the penis and the right obturator muscle, bladder compression, seminal vesicle intact | No | No | No |
| 3                  | Lobular | Hyper | Iso | Hyper | Heterogeneous | Present | Present | Seminal vesical invasion, bladder rectal compression | No | No | No |
| 4                  | Lobular | Hyper | Iso | - | Heterogeneous | Present | Absent | Seminal vesical invasion, bladder rectal compression | No | No | No |
| 5                  | Round | Hype | Iso | - | - | Present | Present | Present | Seminal vesical invasion, rectal compression | No | No | No |
| 6                  | Lobular | Hyper | Iso | - | - | Present | Absent | Present | Seminal vesicle intact, rectal compression | No | No | No |
| 7                  | Irregular | Hyper | Iso | - | - | Present | Absent | Present | Seminal vesical, rectal and bladder invasion, retroperitoneal nodes metastatic | No | Yes | No |
| 8                  | Lobular | Hyper | Iso | - | Heterogeneous | Present | Present | Seminal vesical invasion | No | No | No |
| 9                  | Irregular | Hyper | Hypo | Iso | Hyper | Heterogeneous | Present | Present | Seminal vesical, rectal and bladder invasion | No | No | Yes |
| 10                 | Lobular | Hype | Iso | Hyper | Heterogeneous | Absent | Present | Seminal vesical invasion, bladder compression, rectal invasion | No | No | Yes |
| 11                 | Round | Hype | Hypo | Hyper | - | Heterogeneous | Absent | Present | Seminal vesical and bladder invasion | Yes | Yes | No |
| 12                 | Irregular | Hype | Hypo | Hyper | Heterogeneous | Absent | Present | Seminal vesical and rectal and bladder invasion | No | No | No |
| 13                 | Irregular | Hype | Iso | Hyper | - | Absent | Present | Present | Seminal vesical and bladder invasion, pelvis lymph node metastases, rectal invasion maybe | Yes | No | No |
| 14                 | Irregular | Iso | Iso | Hyper | Homogeneous | Absent | Absent | Seminal vesical, rectal and bladder invasion, pelvis lymph node metastases | No | No | No |
| 15                 | Round | Iso | Iso | Hyper | Homogeneous | Absent | Absent | Seminal vesical and bladder invasion, pelvis lymph node metastases | No | No | No |

MRI: magnetic resonance imaging; T2WI: T2-weighted imaging; T1WI: T1-weighted imaging; DWI: diffusion-weighted imaging; Hyper: hyperintense; Iso: isointense; Hypo: hypointense; -: none