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Case Report

"Another inchworm sign" on dynamic contrast-enhanced magnetic resonance imaging in pediatric patients with cystitis cystica and glandularis: Radiologic-pathologic correlation ☆,☆☆

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ABSTRACT

Cystitis cystica and glandularis is a hyperproliferative disease of the urothelium, and may form a papillary or polypoid mass. Clinically, these mass lesions are often difficult to distinguish from malignant tumors. We present a pediatric patient of cystitis cystica and glandularis with a bladder mass and discuss dynamic contrast-enhanced magnetic resonance imaging (MRI) findings and histopathological profiles, which have not been previously explored in the literature. Dynamic contrast-enhanced MRI showed unique, superficial, strong enhancement that resembles an inchworm in appearance. The term "inchworm sign" is a characteristic finding on diffusion-weighted MRI, proposed as a criterion for T-staging in non-muscle-invasive bladder cancer. We would like to propose another "inchworm sign" on dynamic contrast-enhanced MRI as a new hallmark of cystitis cystica and glandularis, which may differentiate it from a malignant tumor.

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Introduction

Cystitis cystica and glandularis is a common hyperproliferative condition. Metaplasia of the urothelium is induced by irritants such as infection, stones, outlet obstruction, or tumors [1,2]. Cystitis cystica and glandularis can occur at any age, and the prevalence of children with urinary tract infections is reported to be 2.4% [2]. Symptoms include chronic irritability with frequent urination, dysuria, urgency, and hematuria. Surgical resection should be avoided in patients who do not have severe symptoms such as urinary tract obstruction because lesions of cystitis cystica and glandularis are benign. Cystitis cystica and glandularis may form a papillary or polypoid mass [3,4]. These mass lesions may be difficult to distinguish from malignant tumors on imaging. There are few reports of cystitis cystica and glandularis with mass formation [4], and we could not find any reports of gadolinium-enhanced magnetic resonance imaging (MRI) findings in children. We herein present a girl who had diagnosed cystitis cystica and glandularis with bladder mass formation, and discuss the gadolinium-enhanced MRI findings and histopathological profiles. Unique imaging finding of strong enhancement of the lamina propria of the mucosa together with low-signal submucosal edema resembled the archlike "inchworm sign" that is an MRI feature of adult patients with pT1 stage bladder cancer [5].

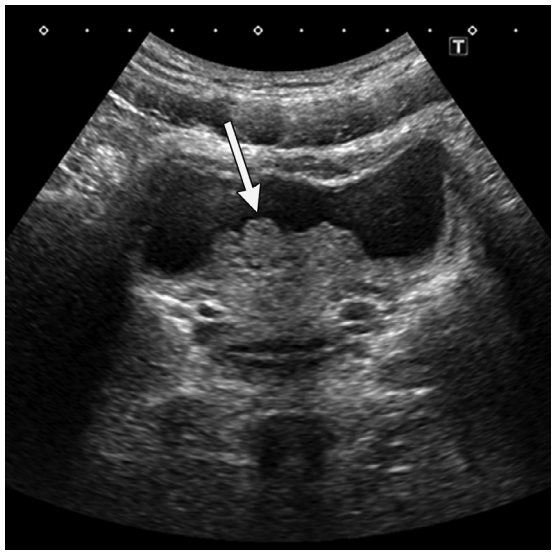

Fig. 1 – Pelvic ultrasonography. Pelvic ultrasonography of a 13-year-old girl with macrohematuria reveals a polypoid mass arising from the anteroinferior wall of the urinary bladder with a "bumpy" appearance, measuring as a relatively small lesion (white arrow), widely attached to the bladder wall, that measured up to 30 mm.

Case presentation

A 13-year-old girl with a medical history of attention deficit hyperactivity disorder visited her family physician because her urinalysis test was positive for occult blood. The patient presented with nocturia for several months. She also had macrohematuria of unknown cause several months earlier. A bladder mass was demonstrated on abdominal ultrasound (US) performed at her family practice and she was referred to our urology department for further investigation and treatment. Her vital signs were normal, and physical examination showed no abnormalities. Blood tests revealed normal renal function. A pelvic US performed at our institution showed a polypoid mass arising from the anteroinferior wall of the urinary bladder with a "bumpy" appearance, a relatively small lesion measuring up to 30 mm (Fig. 1). The mass was widely attached to the bladder wall and color Doppler imaging revealed no obvious increase in vascular flow (not shown). Based on these US findings, the differential diagnosis included benign inflammatory processes such as cystitis cystica and glandularis but also malignant tumors (eg, botryoid type of embryonal rhabdomyosarcoma, malignant lymphoma, inflammatory myofibroblastic tumor and others). There was no hydronephrosis, nor were there any other abnormalities in the urinary tract. She underwent pelvic MR examination for further evaluation. The mass located on the anteroinferior wall of the bladder showed moderate, high-signal intensity in the submucosal region on T2-weighted images (T2WI) (Fig. 2A). The surface of the tumor seemed to be lobulated with a multi-layered appearance and a thin, band-like, hyperintense zone was sandwiched between 2 low-signal layers. The diffusion-weighted MR images showed band-like, hyperintensity zone on the superficial layer of the mass (Fig. 2B). During the early phase of dynamic contrast-enhanced T1-weighted imaging (T1WI), the tumor surface showed strong contrast enhancement together with a low-signal submucosal region in an archlike "inchworm" configuration (Fig. 2C). In addition, the muscle layer in the deep part of the polypoid mass was intact. Delayed-phase, contrast-enhanced T1WI again revealed a multi-layered tumor surface, as did T2WI (Fig. 2D). This unique "inchworm-like" configuration was not clearly demonstrated on DWI as there was no restriction of diffusion. Based on these imaging findings, our final diagnosis was cystitis cystica and glandularis in preference to the malignant tumors mentioned above.

A transurethral bladder biopsy was performed for histological diagnosis. Cystoscopic examination revealed a polypoid mass lesion on the anterior wall of the urinary bladder. Histological examination of the resected tissue revealed nests of von Brunn and mucin-filled goblet cell metaplasia in the lamina propria, which was consistent with cystitis cystica and glandularis (Fig. 3). The resected specimens showed proliferation of blood vessels and dilated vessels in the lamina propria of the mucous membrane, as well as edematous changes. No evidence of dysplasia or malignancy was identified. We thought that resection of the mass was not necessary because urinary tract obstruction was not observed, and decided to follow up with imaging every 6 months. The patient continues to be followed up to 2 years later with no increase in the bladder mass and no appearance of symptoms such as urinary retention.

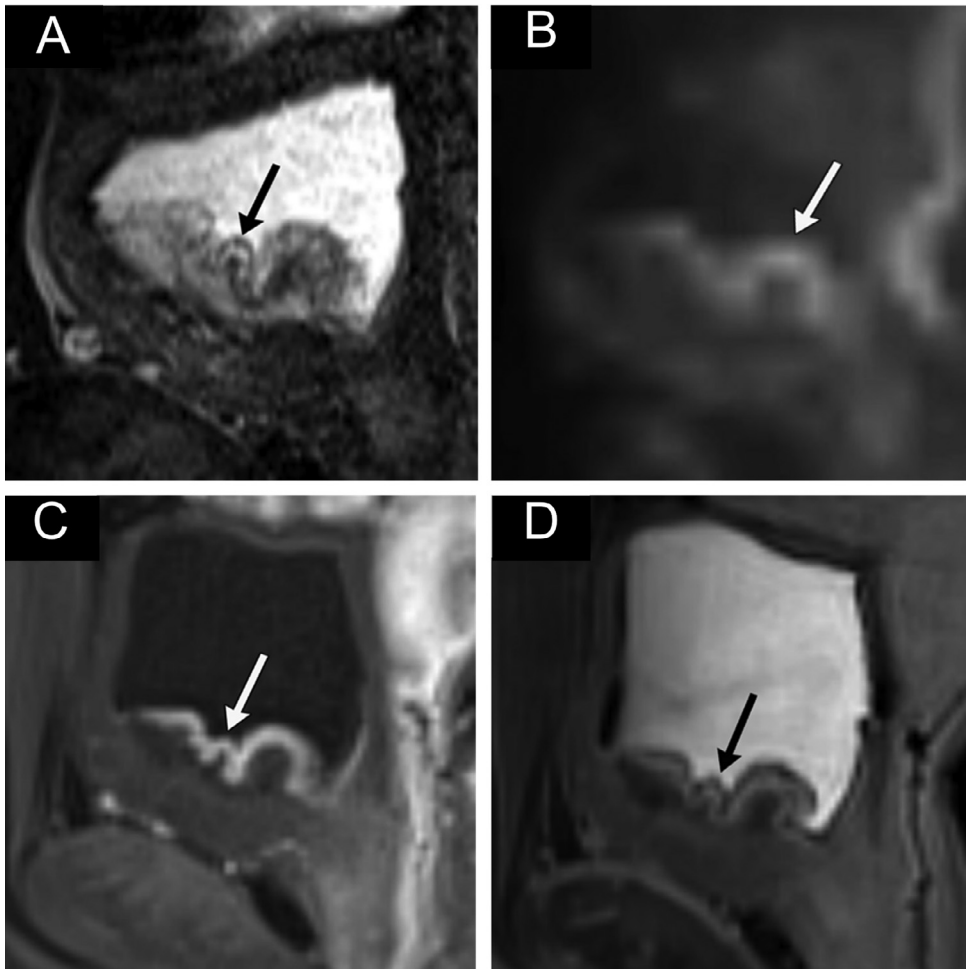

Fig. 2 – Gadolinium-enhanced MR images of the pelvis. T2-weighted images (A) demonstrate a polypoid mass arising from the anterior wall of the urinary bladder. The tumor surface appeared lobulated with a multi-layered appearance and a thinned, band-like, hyperintense zone sandwiched between 2 low-signal layers (a, black arrow). The diffusion-weighted MR images (B) showed band-like, hyperintense zone on the superficial layer of the mass. Dynamic contrast-enhanced MRI (C, D) was performed. In the early phase of dynamic, contrast-enhanced, fat-suppressed T1WI (C), the tumor surface showed strong contrast enhancement together with a low-signal submucosal region resembling an archlike "inchworm" configuration. The delayed phase of the contrast-enhanced MRI (D) again depicted a multi-layered tumor surface also seen on T2WI. The muscle layer in the deep part of the polypoid mass was intact. This unique enhancement pattern suggested the possibility of an inflammatory process rather than a malignant tumor such as a botryoid type rhabdomyosarcoma.

Discussion

Cystitis cystica and glandularis is a hyper-proliferative disease of the urothelium. The urothelium proliferates into buds (nests of von Brunn), which grow down into the lamina propria, and the buds differentiate into the cystic deposits of cystitis cystica or into intestinal columnar mucus-secreting glands, resulting in cystitis glandularis [1,2]. Atypia and muscle invasion is not a feature of this disorder. Patients with cystitis cystica and glandularis rarely develop polypoid masses, however, diffuse thickening of the urinary bladder wall is generally observed in these patients. These mass lesions in cystitis cystica and glandularis may be difficult to distinguish from neoplastic lesions, including malignant tumors.

To the best of our knowledge, there have been no reports of MRI findings of cystitis cystica and glandularis in pediatric patients, otherwise reported only in adult patients [1–3]. MR images show thickening of the mucosal lamina propria beneath the urothelium, and the thickened mucosal lamina propria shows band-like high signal intensity on T2WI [3]. These imaging findings reflect edematous changes and cystic lesions in the suburothelial tissue, and the same imaging characteristics were identified in our pediatric patient. Histopathological examination demonstrated thickening and edematous changes in the mucosal lamina propria. Therefore, we believe that the high signal intensity at the surface of the mass on T2WI reflects thickening and edematous changes in the suburothelial tissue. Marked, superficial contrast enhancement in the arterial phase on dynamic

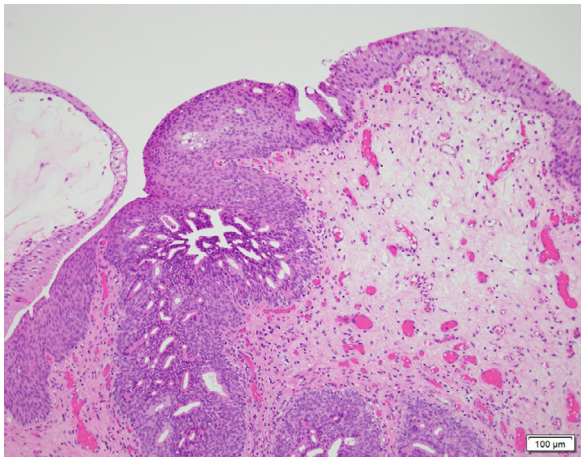

Fig. 3 – Photomicrograph of resected specimen (H-E stain). Nest of von Brunn with cystic changes and mucin filled goblet cell metaplasia was seen in the photomicrograph of resected specimen. These findings are typical of cystitis cystica and glandularis. This resected specimen shows proliferating and dilated blood vessels in the suburothelial layer of the bladder, and edematous changes in suburothelial layer are also observed.

contrast-enhanced MRI may reflect the proliferation and dilation of blood vessels in the lamina propria of the mucosa. The superficial strong enhancement together with submucosal hypointensity takes on an archlike "inchworm" appearance. This area of hypointensity may reflect submucosal edema which existed between the enhanced surface and the muscle layer. These findings strongly suggest that the lesion has not invaded the muscle layer. The "inchworm sign" is known to be a characteristic finding on DWI in non-muscle-invasive early bladder cancer of adult patient introduced by Takeuchi et al [5,6]. They regarded this characteristic finding to be indicative of a pT1 or lower bladder tumor, so dynamic contrast-enhanced images could be skipped [5]. On radiologic-pathologic correlation, the original "inchworm sign" reflects restricted diffusion of localized malignant cells, and "another inchworm sign" reflects the contrast enhancement effect of localized hypervascularity. Therefore, if the lesions were localized in the mucosa and submucosa, they would present strikingly similar MR imaging findings with an "inchworm-like" appearance, despite the etiology, either tumor or proliferative changes, being different. "Another inchworm sign" on dynamic contrast-enhanced MRI may play an important role in suggesting that limited proliferative change in the mucosal lamina propria can exclude the possibility of rhabdomyosarcoma or another pediatric malignant tumor.

Resection of lesions is often necessary in patients with cystitis cystica and glandularis associated with urinary tract obstruction. On the other hand, it is known that these lesions may shrink with untreated follow-up [7]. Since the patient had no urinary tract obstruction, the patient was followed up with routine US. Subsequently, there was no appearance of symptoms such as urinary retention, and the bladder mass did not increase in size.

In conclusion, the thickened mucosal lamina propria showed inchworm-like enhancement in the arterial phase of dynamic contrast-enhanced MRI in a patient with cystitis cystica and glandularis. We would like to propose "another inchworm sign" on dynamic contrast-enhanced MRI as a new hallmark for cystitis cystica and glandularis, a sign which may differentiate this condition from a malignant tumor in the pediatric population.

Authors' contributions

Sota Masuoka and Osamu Miyazaki had the idea for the article. Sota Masuoka and Osamu Miyazaki wrote main body of article. Ayako Imai, Reiko Okamoto, Yoshiyuki Tsutsumi, Mikiko Miyasaka, Yuichi Hasegawa, and Takako Yoshioka performed the literature search and data analysis. Shunsuke Nosaka supervised the whole article. All authors critically revised the report, commented on drafts of the manuscript, and approved the final report.

Patient consent

Informed consent for publication was obtained from the parents of the patient.

Acknowledgment

This case was presented and discussed at 19th Moscow Tokyo Image Forum (MoTIF) as an international tumor board conference on October 3, 2019.

REFERENCES

[1] Coleman JF, Hansel DE. Benign diseases of the bladder. Surg Pathol Clin 2008;1(1):129–58.
[2] Wong-You–Cheong JJ, Woodward PJ, Manning MA, Davis CJ. Inflammatory and nonneoplastic bladder masses: radiologic-pathologic correlation. Radiographics 2006;26(6):1847–68.
[3] Chung AD, Schieda N, Flood TA, Cagiannos I, Kielar AZ, McInnes MDF, et al. Suburothelial and extrinsic lesions of the urinary bladder: radiologic and pathologic features with emphasis on MR imaging. Abdom Imaging 2015;40(7):2573–88.
[4] Bastianpillai C, Warner R, Beltran L, Green J. Cystitis cystica and glandularis producing large bladder masses in a 16-year-old boy. JRSM Open 2018;9(3):205427041774606.
[5] Takeuchi M, Sasaki S, Ito M, Okada S, Takahashi S, Kawai T, et al. Urinary bladder cancer: diffusion-weighted MR imaging–accuracy for diagnosing T stage and estimating histologic grade. Radiology 2009;251(1):112–21.
[6] Arévalo N, Méndez R, Barrera J. "Inchworm sign" in urinary bladder cancer. Abdom Radiol 2018;43(12):3509–10.
[7] Parker C. Cystitis cystica and glandularis: a study of 40 cases. Proc R Soc Med 1970;63(3):239–42.