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Rhabdomyosarcoma of the prostate presenting as acute urinary retention in a 4-year-old child: A case report

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Abstract
Rhabdomyosarcoma is the most common soft-tissue sarcoma of childhood, but primary involvement of the prostate is uncommon and may present with nonspecific lower urinary tract symptoms before progressing to significant bladder-outlet obstruction. We report a 4-year-old boy with FOXO1-negative embryonal/alveolar mixed-type rhabdomyosarcoma of the prostate who presented with acute urinary retention following six weeks of progressive dysuria, weak urinary stream, hesitancy, double voiding, and straining. Examination revealed a markedly distended urinary bladder and a large firm anterior pelvic mass on digital rectal examination. Failed transurethral catheterization necessitated ultrasound-guided suprapubic cystostomy. Pelvic magnetic resonance imaging demonstrated a 6.2 × 5.8 × 6.5 cm heterogeneous prostatic mass with marked diffusion restriction, near-complete obliteration of the prostatic urethra, bladder-neck compression, posterior displacement of the rectum, and bilateral hydroureteronephrosis. Histopathological examination showed malignant rhabdomyoblastic differentiation with embryonal and alveolar morphological components; tumor cells demonstrated diffuse desmin positivity and strong nuclear myogenin/MyoD1 expression. Molecular testing for FOXO1 fusion was negative. Staging investigations showed no distant metastases, and the disease was categorized as Stage III, Clinical Group III. Induction chemotherapy with vincristine, actinomycin-D, and cyclophosphamide resulted in marked tumor regression. The patient subsequently underwent radical cystoprostatectomy with ileal conduit urinary diversion and bilateral pelvic lymph-node dissection, achieving negative margins and greater than 90% tumor necrosis. Adjuvant intensity-modulated radiotherapy was administered, and the child remained in complete radiological remission at 18-month follow-up. This case emphasizes the importance of early evaluation of persistent lower urinary tract symptoms in children and illustrates the diagnostic and therapeutic relevance of integrating histomorphology, immunohistochemistry, molecular FOXO1 status, imaging, and multidisciplinary local-control strategies.

Keywords: embryonal/alveolar rhabdomyosarcoma; FOXO1-negative; pediatric rhabdomyosarcoma; prostate; acute urinary retention; bladder outlet obstruction; VAC chemotherapy; pediatric oncology.

Introduction
Rhabdomyosarcoma (RMS) is the most common malignant soft-tissue sarcoma in children and accounts for approximately 3% of pediatric malignancies. It represents a heterogeneous group of mesenchymal tumors characterized by skeletal-muscle differentiation. Although RMS has historically been classified morphologically into embryonal, alveolar, spindle cell/sclerosing, and pleomorphic subtypes, contemporary classification increasingly integrates molecular abnormalities with morphology and immunophenotype. In particular, the presence or absence of a PAX3::FOXO1 or PAX7::FOXO1 fusion has become an important biological and prognostic determinant and is incorporated into modern risk stratification [1, 2]. The genitourinary tract constitutes an important primary site of childhood RMS. Bladder/prostate tumors predominantly occur in infants and preschool-aged children and often demonstrate rhabdomyoblastic morphology. Clinical manifestations depend largely on tumor location and mass effect and may include dysuria, urinary frequency, hematuria, weak urinary stream, straining, urinary retention, constipation, or a palpable pelvic mass. Because the prostate is deeply situated within the pediatric pelvis, a tumor can attain

considerable dimensions before producing unequivocal clinical signs. Consequently, persistent or progressive urinary symptoms may precede diagnosis by several weeks or months [3, 4]. Magnetic resonance imaging (MRI) is particularly valuable for evaluation of pelvic RMS because it provides accurate delineation of the primary tumor, its relationship to the bladder neck, urethra, rectum and pelvic musculature, regional nodal disease, and treatment response. Current international recommendations emphasize standardized MRI-based evaluation at diagnosis, during treatment, and during post-treatment surveillance [5].

Histopathological diagnosis relies on characteristic morphology supported by immunohistochemical demonstration of myogenic differentiation. Desmin, myogenin, and MyoD1 are among the most useful markers, although molecular testing is now essential for appropriately characterizing tumors with alveolar morphology. Contemporary studies demonstrate that FOXO1 fusion status provides biologically meaningful information beyond conventional histological subclassification [1, 6].

We report a rare case of FOXO1-negative embryonal/alveolar mixed-type rhabdomyosarcoma of the prostate in a 4-year-old boy presenting with acute urinary retention, with emphasis on clinical presentation, MRI characteristics, pathological findings, molecular characterization, multimodal treatment, and short-term outcome.

Case Presentation

A 4-year-old boy was brought to the emergency department of Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka, with severe lower abdominal pain, marked distress, and inability to pass urine for approximately 16 hours. Further history revealed a six-week period of gradually progressive lower urinary tract symptoms characterized by dysuria, weak urinary stream, and hesitancy, double voiding, and increasing straining during micturition. During the preceding five days, the child had passed only small quantities of urine intermittently and had also developed painful defecation and tenesmus. There was no history of gross hematuria, fever, trauma, previous surgery, congenital genitourinary anomaly, or known familial cancer-predisposition syndrome. On presentation, the child appeared anxious and distressed because of pain. His temperature was 36.8°C, heart rate 118 beats/min, respiratory rate 26 breaths/min, and blood pressure 104/68 mmHg. Abdominal examination demonstrated a tense, tender, globular suprapubic swelling extending toward the umbilicus, consistent with an acutely distended urinary bladder. Digital rectal examination revealed a large, smooth, firm-to-hard, non-tender mass arising anteriorly and occupying the deep pelvis, with posterior displacement of the rectum. The upper margin of the mass could not be reached. External genital examination was normal, with bilaterally descended testes. An attempt was made to decompress the bladder using an 8-Fr pediatric Foley catheter. Significant resistance was encountered at the level of the prostatic urethra; therefore, further instrumentation was abandoned to avoid urethral trauma. An ultrasound-guided suprapubic cystostomy was subsequently performed and drained approximately 380 mL of clear urine, resulting in prompt symptomatic improvement. Baseline laboratory investigations showed a hemoglobin concentration of 11.8 g/dL, total leukocyte count of 8,400/µL, and platelet count of 280,000/µL. Serum creatinine was initially 1.1 mg/dL and blood urea nitrogen was 28 mg/dL. Renal function normalized within 48 hours following relief of urinary obstruction. Serum alpha-fetoprotein was 2.1 ng/mL and β-human chorionic gonadotropin was <1.2 mIU/mL. Ultrasonography of the abdomen and pelvis demonstrated a large heterogeneous hypoechoic pelvic mass arising from the prostatic region, measuring approximately 6.0 × 5.5 cm. The tumor displaced the bladder trigone superiorly and was associated with moderate bilateral hydroureteronephrosis. Pelvic MRI demonstrated a well-defined, lobulated, heterogeneous mass centered within the prostate and measuring approximately 6.2 × 5.8 × 6.5 cm, with an estimated volume of approximately 122 cm³. The lesion demonstrated heterogeneous intermediate-to-high signal intensity on T2-weighted imaging with internal areas of altered signal compatible with myxoid, cystic, or necrotic change. Diffusion-weighted imaging at b = 1000 s/mm² demonstrated pronounced high signal intensity with corresponding low signal on the apparent diffusion coefficient map, confirming marked diffusion restriction and high tumor cellularity. The mass markedly compressed and nearly obliterated the prostatic urethra, compromised the bladder neck, and displaced the rectum posteriorly. A thin intervening tissue plane was maintained without definite evidence of transmural rectal invasion (Figure 1).

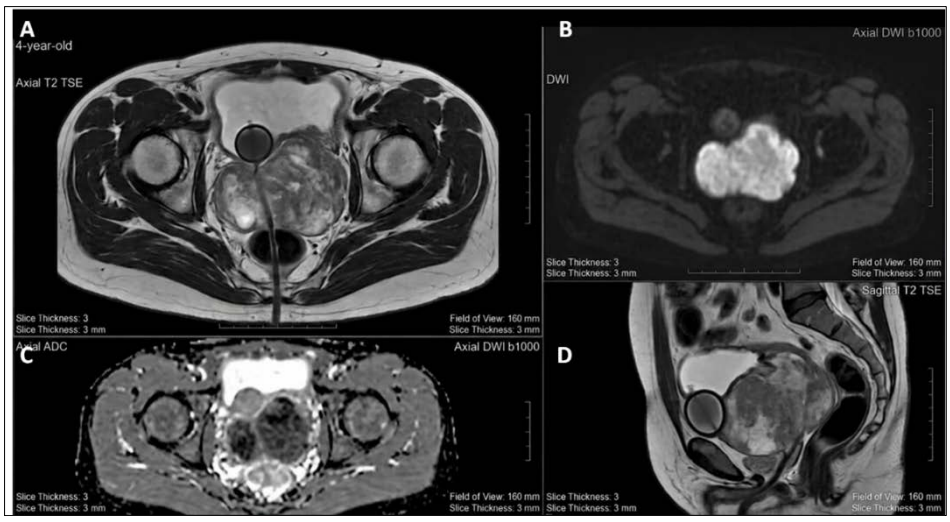


Fig 1: Magnetic resonance imaging findings of embryonal/alveolar mixed-type rhabdomyosarcoma of the prostate

Figure 1A: Axial T2-weighted MRI demonstrates a large, lobulated heterogeneous mass centered in the prostate, producing marked displacement of adjacent pelvic structures. Figure 1B: Axial diffusion-weighted image at b = 1000 s/mm² demonstrates marked hyperintensity within the lesion. Figure 1C: The corresponding ADC map demonstrates low signal intensity, confirming restricted diffusion consistent with a hypercellular malignant neoplasm. Figure 1D: Sagittal T2-weighted MRI demonstrates the craniocaudal extent of the tumor with significant bladder-outlet compression and posterior displacement of the rectum. Staging investigations included contrast-enhanced chest imaging, skeletal evaluation, and bilateral bone-marrow aspiration and trephine biopsy. There was no evidence of pulmonary, osseous, or bone-marrow metastatic disease. Based on the extent of the primary lesion and residual gross disease following diagnostic biopsy, the tumor was categorized as Stage III, Clinical Group III.

A transrectal ultrasound-guided core biopsy was performed under general anesthesia. Histopathological examination demonstrated a densely cellular malignant neoplasm with alternating morphological features of embryonal and alveolar differentiation. Tumor cells were predominantly small round-to-oval or spindle-shaped cells with hyperchromatic nuclei and scant cytoplasm, together with scattered larger rhabdomyoblasts containing abundant eosinophilic cytoplasm. Areas demonstrating alveolar-type architectural differentiation were identified in association with the embryonal component. Mitotic activity was prominent. Immunohistochemical examination demonstrated strong diffuse cytoplasmic expression of desmin and strong nuclear positivity for myogenin and MyoD1, confirming skeletal-muscle-lineage differentiation. Cytokeratin, S100, CD99, and chromogranin were negative, helping exclude other pediatric small round-cell malignancies. The overall morphological and immunophenotypic findings supported a final diagnosis of embryonal/alveolar mixed-type rhabdomyosarcoma (Figure 2). Molecular analysis for FOXO1 fusion was performed and was negative. Thus, despite the presence of an alveolar morphological component, the tumor was classified molecularly as FOXO1 fusion-negative RMS. Molecular characterization was particularly relevant because contemporary RMS risk assessment increasingly prioritizes FOXO1 fusion status over alveolar morphology alone.

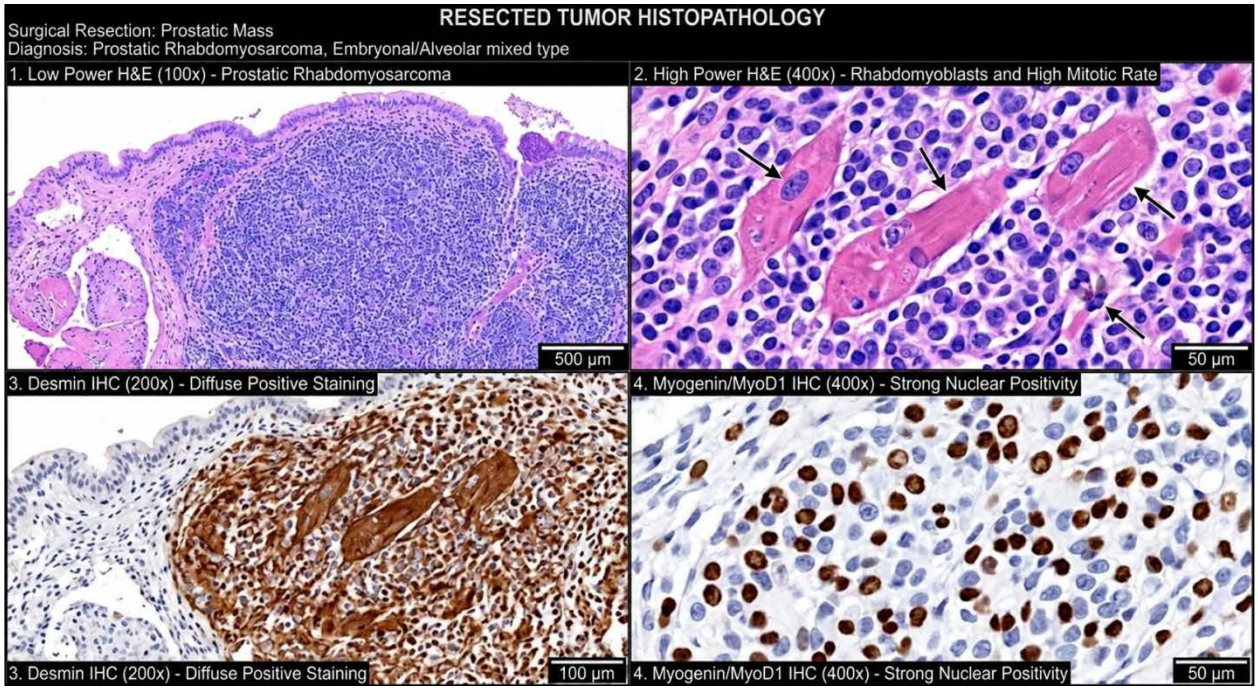


Fig 2: Histopathological and immunohistochemical features of embryonal/alveolar mixed-type rhabdomyosarcoma

Figure 2.1: Low-power hematoxylin and eosin-stained section (×100) showing a densely cellular malignant rhabdomyoblastic neoplasm with mixed growth pattern. Figure 2.2: High-power H&E section (×400) demonstrating prominent rhabdomyoblasts with abundant eosinophilic cytoplasm, nuclear atypia, and increased mitotic activity (arrows). Figure 2.3: Desmin immunohistochemistry (×200) showing strong diffuse cytoplasmic positivity in the neoplastic cells. Figure 2.4: Myogenic-marker immunohistochemistry (×400) demonstrating strong nuclear positivity for myogenin/MyoD1, supporting rhabdomyoblastic differentiation. Following multidisciplinary discussion, the patient was commenced on systemic chemotherapy using a vincristine, actinomycin-D, and cyclophosphamide (VAC) regimen. The institutional treatment record documented vincristine 1.5 mg/m² intravenously, actinomycin-D 0.015 mg/kg, and cyclophosphamide 1.2 g/m² with mesna uroprotection according to the planned treatment schedule. Twelve cycles of induction treatment were administered over approximately 36 weeks. Treatment was generally tolerated, although episodes of Grade 3 febrile neutropenia occurred and were managed with supportive therapy and granulocyte colony-stimulating factor. Renal, hepatic, and cardiac parameters were monitored throughout therapy.

Post-chemotherapy response assessment by pelvic MRI demonstrated marked reduction in tumor size, with the residual lesion measuring approximately 2.1 × 1.8 × 2.2 cm compared with the pretreatment dimensions of 6.2 × 5.8 × 6.5 cm. This represented greater than 65% reduction in the

reported linear dimensions, with substantially improved delineation from the adjacent pelvic structures.

Following chemotherapy, definitive surgical management was undertaken with radical cystoprostatectomy, ileal conduit urinary diversion, and bilateral pelvic lymph-node dissection. Intraoperative frozen-section examination confirmed negative resection margins. Histopathological evaluation of the resection specimen demonstrated extensive treatment response with greater than 90% tumor necrosis and residual embryonal/alveolar mixed-type rhabdomyosarcoma. All 12 resected pelvic lymph nodes were negative for metastatic tumor, and the surgical margins were free of disease.

The child subsequently received adjuvant intensity-modulated radiation therapy to the tumor bed at a total dose of 41.4 Gy delivered in 23 fractions. At 18 months following completion of multimodal therapy, clinical assessment and serial pelvic MRI demonstrated complete radiological remission with no evidence of local recurrence or distant metastatic disease.

Discussion

Rhabdomyosarcoma of the bladder/prostate region represents a therapeutically challenging subset of childhood RMS because the anatomical confines of the pelvis allow tumors to produce substantial urinary and bowel morbidity while simultaneously complicating local-control strategies. In the present case, a six-week history of progressive urinary obstruction culminated in acute urinary retention. Contemporary reviews of pediatric genitourinary RMS similarly describe dysuria, hematuria, difficulty voiding, constipation, urinary retention, and pelvic mass effect as characteristic manifestations of bladder/prostate disease [3,4]. Progressive lower urinary tract symptoms in a preschool-aged child should therefore prompt evaluation for anatomical obstruction and pelvic neoplasia when symptoms are persistent, unexplained, or refractory to conventional treatment. Digital rectal examination was particularly informative in this child, immediately identifying a large anterior pelvic mass. Although such examination must be performed appropriately and selectively in children, the finding substantially narrowed the differential diagnosis and prompted definitive cross-sectional imaging. Emergency decompression presented an additional challenge because the tumor had almost completely compromised the prostatic urethra. Repeated forceful urethral instrumentation could have produced trauma, hemorrhage, or false passage formation. Recent evidence-based pediatric RMS surgical recommendations support the least invasive safe approach when tumor-associated obstruction requires intervention [7]. The ultrasound-guided suprapubic cystostomy used in this patient achieved rapid decompression without repeated manipulation of the obstructed urethra. MRI played a critical role in local staging and subsequent assessment of response. The lesion showed heterogeneous T2 signal intensity, pronounced restriction on diffusion-weighted imaging, and low ADC signal, compatible with the high cellularity expected in RMS. MRI also demonstrated the relationship of the tumor to the bladder neck, urethra, and rectum, thereby providing information required for multidisciplinary local-treatment planning. The INSTRuCT imaging consensus recommends systematic MRI evaluation of RMS at diagnosis and throughout treatment to standardize measurement of the primary lesion, determine anatomic extension, and assess therapeutic response [5].

The pathological features of the present tumor are of particular interest because the lesion demonstrated combined embryonal and alveolar morphological differentiation. Historically, alveolar morphology was associated with a substantially poorer prognosis, and histological subtype played a major role in treatment stratification. However, advances in molecular pathology have demonstrated that PAX3::FOXO1 and PAX7::FOXO1 fusion status is more biologically informative than alveolar morphology alone. Modern reviews therefore emphasize integration of histological pattern with molecular findings [1, 2, 6]. In the present patient, molecular testing for FOXO1 fusion was negative, despite the presence of an alveolar component histologically. This distinction has important implications. Fusion-negative tumors showing alveolar morphology have been recognized as biologically different from canonical PAX::FOXO1 fusion-positive alveolar RMS, and contemporary therapeutic protocols increasingly classify RMS according to fusion status rather than relying exclusively on histological designation [6,8]. A recent large analysis of alveolar RMS similarly demonstrated that PAX3/7::FOXO1 fusion status remains a major factor incorporated into modern risk stratification [9]. Thus, reporting the present tumor as embryonal/alveolar mixed-type RMS, FOXO1 fusion-negative accurately preserves its histomorphological appearance while also documenting its biologically important molecular profile.

Immunohistochemistry provided additional diagnostic confirmation. Strong diffuse cytoplasmic desmin positivity supported skeletal-muscle differentiation, whereas strong nuclear myogenin and MyoD1 expression confirmed rhabdomyoblastic differentiation. However, immunophenotyping should not replace molecular testing when alveolar morphology is present. Contemporary pathology guidance emphasizes that integrated morphology, immunohistochemistry, and molecular testing provide the most robust framework for diagnosis and reporting of pediatric RMS [2, 10].

The disease in this patient was categorized as Stage III, Clinical Group III and was nonmetastatic. Systemic chemotherapy is essential even in apparently localized RMS because of the potential for occult micrometastatic disease. VAC therapy has constituted a central component of RMS treatment for decades, although contemporary protocols increasingly modify systemic treatment according to clinical and molecular risk. The importance of FOXO1-based stratification was demonstrated in the Children's Oncology Group ARST1431 trial, which used fusion status in defining intermediate-risk disease. That randomized phase III study evaluated VAC/VI with or without temsirolimus and demonstrated the continuing evolution toward molecularly informed treatment strategies [11].

The marked response to induction chemotherapy in the present child was clinically important. Tumor dimensions decreased from approximately 6.5 cm at their maximum dimension to approximately 2.2 cm, creating more favorable circumstances for subsequent local treatment. Tumor-volume response itself may carry prognostic information in fusion-negative RMS. Recent data indicate that early tumor-volume reduction may be associated with overall survival and local failure in FOXO1 fusion-negative embryonal and spindle cell/sclerosing RMS, although such findings should

not be directly extrapolated as an individual prognostic prediction in a single mixed-morphology case [12].

Achieving adequate local control while minimizing lifelong functional morbidity remains one of the principal difficulties in bladder/prostate-region RMS. Historically, radical pelvic surgery was frequently employed, but contemporary practice increasingly considers chemotherapy response, residual tumor anatomy, feasibility of complete resection, radiotherapeutic options, age, expected urinary function, and long-term survivorship before selecting a local-control strategy. Evidence-based surgical guidelines consequently favor individualized surgical planning rather than routine radical excision [7].

Delayed primary excision after induction chemotherapy may be useful in selected patients with Group III RMS. Lautz *et al*. demonstrated that delayed primary excision could permit effective local control and, in appropriate circumstances, modification of radiotherapy exposure, although the potential for organ loss and functional consequences remains important [13]. In the present child, substantial chemotherapy-induced regression was followed by radical cystoprostatectomy with an R0 resection and more than 90% tumor necrosis. The absence of metastatic disease in all 12 pelvic lymph nodes was an additional favorable pathological finding. At the same time, increasingly sophisticated bladder-preserving approaches demonstrate that radical surgery is not mandatory for every bladder/prostate-region RMS. Lobo *et al*. reported that conservative surgery combined with high-dose-rate brachytherapy achieved favorable urinary functional outcomes in selected children with localized fusion-negative bladder/prostate RMS, with most surviving patients retaining urethral voiding and daytime continence [14]. Additional contemporary series have similarly demonstrated that bladder-preserving surgery, with or without brachytherapy, can provide useful functional results in carefully selected patients [15]. These observations highlight why radical cystoprostatectomy should be viewed as an individualized local-control decision dictated by tumor anatomy and oncological requirements rather than as a universal approach.

Radiotherapy remains an important component of local control for many patients with Group III disease. Nevertheless, simply escalating radiation dose does not necessarily improve local outcomes. Recent results from ARST1431 demonstrated that increasing the radiotherapy dose to 59.4 Gy in patients with tumors larger than 5 cm and residual gross disease did not significantly improve local control, emphasizing the complex interaction among tumor biology, initial size, response, surgery, and radiotherapy [16]. The patient in the present report received postoperative IMRT at 41.4 Gy in 23 fractions following complete surgical resection.

The most recent INSTRuCT international consensus recommendations for bladder/prostate RMS, published in 2026, emphasize that local therapy should be individualized through multidisciplinary assessment and should incorporate tumor location, dimensions, patient age, nodal involvement, systemic-treatment response, surgical feasibility, expected functional outcomes, and available radiotherapeutic expertise [17]. This approach is particularly relevant in very young children because achieving long-term cure must be balanced against urinary, renal, bowel, reproductive, skeletal, and radiation-related late effects.

The 18-month disease-free follow-up observed in this child represents an encouraging early outcome but is insufficient to establish long-term cure. Continued surveillance is required to identify local or metastatic recurrence and treatment-related late effects. This is particularly important following radical cystoprostatectomy, urinary diversion, systemic chemotherapy, and pelvic irradiation. Long-term urological series of children treated for bladder/prostate RMS have demonstrated the potential for urinary obstruction, bladder dysfunction, infection, calculi, and other functional complications, emphasizing the need for prolonged multidisciplinary survivorship care [18].

This case therefore illustrates several clinically relevant features: acute urinary retention can be the presenting manifestation of a large pelvic RMS; MRI provides essential anatomical and response information; mixed embryonal/alveolar morphology requires molecular correlation; and negative FOXO1 fusion testing materially refines characterization of a tumor containing an alveolar morphological component. Finally, optimal management requires coordinated systemic and local treatment with careful consideration of both oncological control and long-term functional morbidity.

Conclusion

FOXO1-negative embryonal/alveolar mixed-type rhabdomyosarcoma of the prostate is an uncommon pediatric malignancy that may initially manifest through progressive lower urinary tract obstruction and eventually present as acute urinary retention. Persistent dysuria, weak urinary stream, straining, constipation, or unexplained urinary retention in a young child should prompt careful abdominal and pelvic evaluation and early cross-sectional imaging. In this patient, MRI demonstrated a large hypercellular prostatic mass with severe bladder-outlet compromise, while histopathology and immunohistochemistry established rhabdomyoblastic differentiation with mixed embryonal and alveolar morphological features. Molecular testing confirmed the absence of a FOXO1 fusion, an important finding in contemporary RMS classification and risk assessment. Induction VAC chemotherapy produced marked tumor regression, enabling definitive local therapy with radical cystoprostatectomy, negative-margin resection, and postoperative radiotherapy. Complete radiological remission was maintained at 18 months. The case shows the importance of combining histomorphology with molecular characterization and supports multidisciplinary, individualized treatment planning for pelvic RMS, with continued long-term surveillance for disease recurrence and treatment-related functional sequelae.

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