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Foreword

A Note from the Editorial Board

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uInnovation is a scientific magazine published by United Imaging Healthcare that has been successfully distributed for over past three years. It aims to serve as a platform for sharing ground-breaking advancements, emerging trends, and future possibilities in the vast expanse that is oncology.

uInnovation is currently in its fourth edition. This year's edition will inform, engage, and inspire you about the latest developments and applications of United Imaging Healthcare. This journal includes quick read sections for those in a rush, and appealing images to promote visual understanding.

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Clinical Utility of Diuretic FDG PET/MR in the Evaluation and Locoregional Staging of Urinary Bladder Cancer

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Background

Carcinoma of the urinary bladder remains a formidable clinical challenge due to its heterogeneous presentation. Some patients may present with hematuria, while others experience nonspecific symptoms such as urinary frequency, urgency, or pelvic pain. A subset of patients may remain asymptomatic, with the disease detected only during routine check-ups.

Accurate staging and detection of local recurrence or metastatic spread are often difficult because of the high background tracer uptake in the bladder. Positron emission tomography (PET) imaging, particularly when combined with magnetic resonance imaging (MRI), has emerged as an important tool in the management of muscle-invasive and recurrent bladder cancer. However, the inherent limitation of FDG PET lies in the marked urinary excretion of 18F-fluorodeoxyglucose (FDG), which traditionally hampers its diagnostic utility.

To overcome this challenge, forced diuresis—achieved through administration of furosemide along with oral hydration—can be incorporated into PET protocols. This reduces urinary tracer activity, thereby improving the visualization of bladder wall lesions as well as perivesical and pelvic lymph nodes. There is growing interest in the role of diuretic-assisted PET/MR in this context.

This article discusses the technique, diagnostic performance, and staging implications of diuretic-assisted PET/MR in urinary bladder carcinoma and compares different modalities in pre and post-diuretic scenarios.

Imaging Challenges in Urinary Bladder Carcinoma

CT, MRI, and dynamic contrast-enhanced MRI provide valuable anatomical information; however, none achieve complete accuracy in staging, reflecting the limitations of morphology-based imaging.

Primary bladder lesions are particularly difficult to evaluate due to the physiology of tracer excretion. FDG, the most commonly used oncologic PET tracer, is excreted through the kidneys and accumulates in the urinary tract. This intense background activity can obscure primary lesions and adjacent lymph node or perivesical involvement. As a result, early detection and precise staging—critical for treatment planning in muscle-invasive bladder cancer—are frequently hampered by FDG-laden urine.

On conventional CT, nodal staging is based on size and morphology, but this is insufficient to distinguish reactive hyperplasia from true metastatic disease. In contrast, PET and MRI provide functional information, such as hypermetabolic activity on PET and diffusion restriction on MRI. Yet, the urinary accumulation of FDG continues to limit interpretation, resulting in potential misdiagnosis and false negatives.

These limitations provide the rationale for incorporating functional imaging strategies alongside forced diuresis to enhance diagnostic accuracy.

Forced Diuresis in PET Imaging

Concept of Forced Diuresis

Forced diuresis involves administering a potent diuretic, most commonly furosemide, together with oral hydration, followed by a delay in image acquisition. This promotes urinary washout of FDG, thereby reducing intravesical activity and enhancing the tumor-to-background contrast. The approach simplifies the detection of hypermetabolic bladder wall lesions and adjacent lymphatic spread.

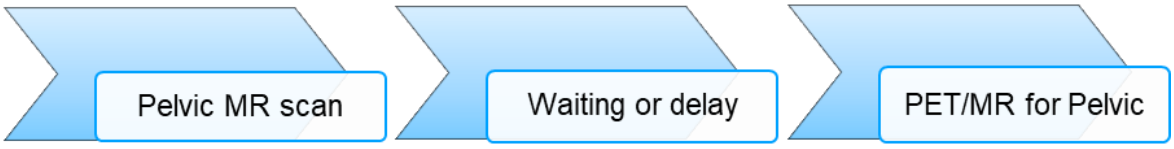
Implementation in PET/MR Protocol

The sequence of steps in the clinical protocol was as follows:

Step	Procedure
Baseline scan	Baseline PET/MR scan ~60 min post-FDG injection
Administration of Diuretic	Administer ~20 mg IV furosemide + ≥500 mL oral hydration

Waiting time	Encourage multiple voids over ~30–60 min
Delayed scan	Acquire delayed pelvic PET/MR scan (90–120 min post-injection)
Post processing	Measure SUVmax, MTV, TLG; review in multidisciplinary setting

Patients fasted prior to FDG administration, and blood glucose levels were confirmed to be within acceptable limits. Following FDG injection, intravenous hydration and furosemide were administered approximately 60–90 minutes later. After an additional delay of 60–90 minutes (resulting in a total imaging time of about 150–180 minutes post-injection), repeat scans were obtained. This delay was critical for reducing bladder tracer activity to near-background levels and minimizing false-positive findings from urinary contamination.



The whole-body PET/MR was performed in 4 beds with 5min per bed. The pre-diuretic pelvic MR scan included GRE Quick (1min 40sec) for MRAC fat suppression, T2 FS arms for reduced motion artifacts (6 to 7mins), T2 SSFSE during breath-holding (3min), and diffusion weighted imaging (about 8min). The delayed PET/MR pelvic scan protocol included MRAC (3min), Axial T2 FSE (3.25min), STIR axial (3.25 min), Diffusion weighted imaging (4min), 3D T1 VIBE (18sec), and 3D T2 Axial MX (2.25 min).

PET/MR provides high soft tissue contrast with MRI, complementing PET's metabolic information. Without measures to reduce bladder activity, however, PET/MR suffers the same pitfalls as PET/CT. Forced diuresis significantly improves image clarity by minimizing urinary tracer interference and is therefore a valuable adjunct to PET/MR in urothelial imaging.

Preliminary findings from Diuretic PET/MR Studies

In a pilot study of patients with bladder masses, diuretic PET/MR was incorporated to address urinary FDG interference. The aim was to assess the utility of delayed imaging for evaluation of bladder lesions and pelvic nodal metastases.

MRI identified the bladder lesion in all patients. PET, after diuretic administration, confirmed hypermetabolic uptake in the same regions, supporting tumor detection. PET/MR improved detection of pelvic nodal involvement, aiding surgical planning for pelvic lymph node dissection.

Noticeable feature of Diuretic PET/MR	**Advantage**
Reduced FDG Interference	Significant lowering of bladder FDG
Soft tissue delineation on MRI	Superior distinguishing of residual tumour from post-treatment fibrosis
Multiparametric assessment	Improvement in tumour characterization, treatment response evaluation, and recurrence detection
Radiation exposure	Reduced cumulative dose particularly for patients requiring serial imaging

Conclusion

This study highlights two applications of diuretic-assisted PET/MR in bladder cancer: (1) preoperative staging of muscle-invasive disease with improved lesion and nodal assessment, and (2) restaging in suspected recurrence.

Diuretic-assisted FDG PET/MR offers a promising advancement in the evaluation and locoregional staging of urinary bladder carcinoma. By overcoming the long-standing challenge of urinary tracer interference, this technique significantly enhances the detection of bladder wall lesions and improves confidence in pelvic nodal assessment. The integration of PET's metabolic information with MRI's superior soft-tissue characterization provides a comprehensive, multiparametric evaluation in a single imaging session.

Beyond staging, diuretic PET/MR holds considerable value in restaging and surveillance, where distinguishing between recurrence and post-treatment changes is often challenging on conventional imaging.

While early studies demonstrate encouraging results, larger prospective, multicenter trials are warranted to validate its diagnostic accuracy, establish standardized protocols, and define its role in clinical decision-making. With further refinement and broader adoption, diuretic PET/MR has the potential to become an integral component of personalized management strategies for urinary bladder cancer.

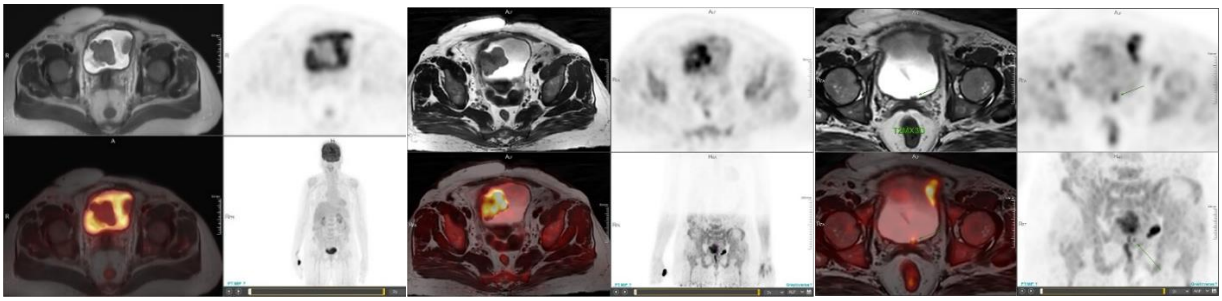


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Figure 1: Comparison of pre and post-diuretic PET/MR demonstrating significant improvement in the detection of the primary tumour involving the bladder wall. Top row in all show Axial T2-weighted images while bottom show fused PET/MR images. A: T2w showing partially distended urinary bladder with two polypoid lesions along lateral walls of the bladder. Fused image shows urinary radioactivity occupying the bladder cavity obscuring bladder lesion FDG uptake B: Post-Diuretic fused image and 3DMIP images reveal intense tracer uptake in the multiple bladder lesions C: Post-Diuretic fused images and 3DMIP images (green arrow) reveal small tracer avid sessile lesion along left side of trigone of urinary bladder medial to vesicoureteric junction.

Author Biography

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Dr. Pawan G. Shinkar is a seasoned radiologist at Omega Hospital, Banjara Hills, Hyderabad, with over 17 years of experience in diagnostic and interventional imaging. He earned his MBBS from the Maharashtra University of Health Sciences in Nashik (2008), followed by a DNB in Radio-Diagnosis from Lokmanya Tilak Municipal Medical College, Mumbai (2010), and a DMRE diploma from I-Care Eye Hospital (2013). Dr. Shinkar specializes in a broad spectrum of radiological services, including contrast radiography, vascular imaging, interventional diagnostics, uterine artery embolization, and neuroradiology. He is also a member of the Indian Radiological & Imaging Association and has published work in the Indian Journal of Nuclear Medicine.

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