

ct guided prostate biopsy

CT Guided Prostate Biopsy: A Modern Approach to Accurate Prostate Cancer Diagnosis

ct guided prostate biopsy is an advanced diagnostic procedure that has transformed the way clinicians detect and evaluate prostate cancer. As prostate cancer remains one of the most common cancers among men globally, accurate and minimally invasive diagnostic methods are crucial. This technique utilizes computed tomography (CT) imaging to precisely guide the biopsy needle into suspicious areas of the prostate, enabling targeted tissue sampling that enhances diagnostic accuracy.

In this article, we will explore the intricacies of CT guided prostate biopsy, including how it works, its benefits compared to traditional biopsy methods, potential risks, and what patients can expect before, during, and after the procedure. Whether you're a patient seeking information or a healthcare professional interested in the latest diagnostic tools, this comprehensive guide will provide valuable insights.

Understanding CT Guided Prostate Biopsy

A prostate biopsy involves removing small samples of tissue from the prostate gland to examine them for cancer cells. Traditionally, biopsies have been performed using transrectal ultrasound (TRUS) guidance, where an ultrasound probe inserted into the rectum helps guide the needle. However, TRUS biopsies may sometimes miss cancerous lesions, particularly those located in hard-to-reach areas of the prostate.

CT guided prostate biopsy employs computed tomography imaging to obtain detailed cross-sectional images of the prostate and surrounding tissues. This imaging technique allows physicians to visualize the exact location of suspicious lesions identified in prior scans or clinical exams. Using CT imaging, the biopsy needle can be precisely directed to areas that are most likely to harbor cancer, improving the chances of an accurate diagnosis.

How Does CT Guided Prostate Biopsy Work?

During the procedure, the patient typically lies on a CT scanner table. After local anesthesia is administered to minimize discomfort, the radiologist or urologist uses real-time CT images to navigate the biopsy needle through the perineum (the area between the scrotum and anus) or occasionally transrectally. The CT images provide a clear roadmap, allowing the clinician to avoid critical structures like blood vessels and nerves.

Once the needle reaches the targeted area within the prostate, a small tissue sample is extracted. Multiple samples may be taken from different regions to ensure comprehensive evaluation. These tissue cores are then sent to a pathology lab where they are examined for the presence of cancer cells, their aggressiveness, and other characteristics.

Advantages of CT Guided Prostate Biopsy

CT guided prostate biopsy offers several distinct benefits over conventional biopsy techniques, making it an attractive option for both patients and clinicians.

1. Enhanced Precision

One of the biggest advantages is the heightened precision in targeting suspicious lesions. CT imaging provides high-resolution, three-dimensional views of the prostate, enabling the biopsy needle to reach areas that might be missed with ultrasound guidance alone. This is especially valuable when prior imaging (like MRI) has identified suspicious nodules that require confirmation.

2. Reduced Sampling Errors

Traditional random or systematic biopsies can lead to sampling errors, where cancerous tissue may be overlooked due to the blind nature of the procedure. CT guided biopsy focuses on specific areas of concern, reducing the risk of false negatives and increasing diagnostic confidence.

3. Minimally Invasive with Lower Complication Rates

The use of CT guidance allows for precise needle placement, minimizing trauma to surrounding tissues. This approach may lower the risk of complications such as bleeding, infection, or damage to adjacent organs, which can sometimes occur with less targeted methods.

4. Useful for Complex Cases

In patients with previous negative biopsies but ongoing suspicion of prostate cancer, CT guided biopsy can help detect cancers that were previously missed. It is also beneficial when MRI guidance is unavailable or contraindicated, providing an alternative imaging modality for biopsy navigation.

Preparing for a CT Guided Prostate Biopsy

Prior to undergoing a CT guided prostate biopsy, patients should follow specific preparation steps to ensure the procedure goes smoothly.

Medical Evaluation and Imaging

Your doctor will review your medical history, current medications, and previous imaging studies such

as MRI or ultrasound scans. Blood tests, including prostate-specific antigen (PSA) levels and coagulation profiles, may be ordered to assess bleeding risk.

Medication Adjustments

If you are taking blood thinners (anticoagulants or antiplatelet drugs), your doctor might advise pausing them several days before the biopsy to reduce bleeding risk. Always consult with your healthcare provider before stopping any medication.

Fasting and Hygiene

Depending on the protocol, you may be asked to fast for a few hours before the procedure. Additionally, you might receive instructions on bowel preparation or antiseptic cleansing to minimize infection risk.

What to Expect During the Procedure

The CT guided prostate biopsy is usually performed on an outpatient basis and typically takes about 30 to 60 minutes.

Step-by-Step Overview

1. **Positioning:** You will lie on the CT table, usually on your back or side, depending on the approach.
2. **Anesthesia:** Local anesthesia is administered to numb the biopsy site, ensuring minimal discomfort.
3. **Imaging and Needle Insertion:** The radiologist acquires initial CT images to locate the prostate and suspicious lesions. Under continuous CT guidance, the biopsy needle is inserted carefully.
4. **Tissue Sampling:** Multiple core samples are collected from targeted areas.
5. **Post-Biopsy Imaging:** Additional scans may be done to check for immediate complications like bleeding.

During the procedure, you might feel mild pressure or a brief pinching sensation but generally should not experience significant pain. Communication with the medical team is encouraged if you feel uncomfortable.

Potential Risks and Complications

Though CT guided prostate biopsy is generally safe, like all invasive procedures, it carries some risks.

Common Side Effects

- Mild bleeding in urine or stool
- Temporary discomfort or soreness at the biopsy site
- Minor swelling or bruising

Less Common but Serious Risks

- Infection, which may require antibiotics or hospitalization
- Significant bleeding requiring medical intervention
- Urinary retention due to swelling or trauma

Your healthcare team will provide detailed instructions on signs to watch for and when to seek medical attention after the biopsy.

Post-Procedure Care and Follow-Up

After the biopsy, patients are usually monitored briefly before being discharged home.

Recovery Tips

- Rest for the remainder of the day and avoid strenuous activities.
- Drink plenty of fluids to flush out the urinary tract.
- Avoid sexual activity and heavy lifting for a few days.
- Follow prescribed antibiotics if given to prevent infection.

Understanding Results

Pathology results typically take several days to a week. Your doctor will discuss the findings with you, including whether cancer cells were detected, their grade or aggressiveness, and possible next steps. In some cases, additional imaging or biopsies may be recommended to clarify the diagnosis.

Comparing CT Guided Biopsy to Other Imaging-Guided Techniques

While CT guided prostate biopsy offers many advantages, it's important to understand how it fits alongside other imaging-guided methods, such as MRI-fusion biopsy and traditional ultrasound-guided biopsy.

MRI-Guided Biopsies

Multiparametric MRI (mpMRI) has become a gold standard for prostate imaging due to its superior soft tissue contrast and ability to identify suspicious lesions. MRI-guided biopsies or MRI-ultrasound fusion biopsies combine detailed MRI visualization with real-time ultrasound guidance to enhance targeting.

Why Choose CT Guidance?

CT guided biopsy may be preferred when MRI is contraindicated (e.g., patients with pacemakers or metal implants), unavailable, or when prior imaging has already demonstrated lesions visible on CT. Additionally, CT scanners are more widely accessible in some clinical settings.

Emerging Advances and Future Directions

The field of prostate cancer diagnosis is rapidly evolving. Researchers are exploring ways to integrate CT guided prostate biopsy with advanced imaging techniques, artificial intelligence, and molecular diagnostics to improve detection rates further and personalize treatment.

For example, combining PET/CT imaging with specific prostate cancer tracers may allow even more precise targeting of aggressive tumors during biopsy. Similarly, robotic-assisted biopsy devices guided by CT imaging are being developed to enhance accuracy and patient comfort.

Understanding the role of CT guided prostate biopsy within this evolving landscape helps patients and clinicians make informed decisions tailored to individual needs.

Navigating prostate cancer diagnosis can be challenging, but advances like CT guided prostate biopsy offer hope for more accurate and less invasive detection. By harnessing the power of detailed imaging, this procedure helps ensure that suspicious areas are sampled precisely, reducing uncertainty and guiding appropriate care. If you or a loved one are facing the prospect of a prostate biopsy, discussing the option of CT guidance with your healthcare provider might open doors to better outcomes and peace of mind.

Frequently Asked Questions

What is a CT-guided prostate biopsy?

A CT-guided prostate biopsy is a minimally invasive procedure where computed tomography (CT) imaging is used to precisely guide the needle to obtain tissue samples from the prostate for diagnostic purposes.

How does CT guidance improve prostate biopsy accuracy?

CT guidance provides detailed cross-sectional images that help clinicians accurately target suspicious areas within the prostate, increasing the likelihood of detecting cancerous tissues compared to traditional biopsy methods.

What are the benefits of a CT-guided prostate biopsy over other biopsy techniques?

Benefits include enhanced visualization of prostate anatomy, improved targeting of lesions, reduced risk of sampling errors, potentially fewer biopsy cores needed, and better detection of clinically significant prostate cancer.

Are there any risks associated with CT-guided prostate biopsy?

Risks include typical biopsy complications such as bleeding, infection, pain, and discomfort. Additionally, exposure to radiation during CT imaging is a consideration, though levels are generally low and deemed safe for diagnostic purposes.

Who is an ideal candidate for a CT-guided prostate biopsy?

Ideal candidates are patients with suspicious prostate lesions identified on imaging (e.g., MRI) where precise targeting is necessary, those with previous negative biopsies but persistent clinical suspicion, or when other biopsy methods are inconclusive or not feasible.

Additional Resources

CT Guided Prostate Biopsy: An In-Depth Review of Technique, Benefits, and Clinical Applications

ct guided prostate biopsy is a diagnostic procedure that utilizes computed tomography (CT) imaging to accurately localize and sample prostate tissue suspected of harboring malignancy. This technique represents an evolution in prostate cancer diagnostics, offering a precise alternative to traditional biopsy methods. As prostate cancer remains one of the leading malignancies affecting men worldwide, advancements in biopsy guidance techniques continue to shape clinical decision-making and patient outcomes.

Understanding CT Guided Prostate Biopsy

Prostate biopsy is an essential step in diagnosing prostate cancer, typically prompted by elevated prostate-specific antigen (PSA) levels or abnormal digital rectal examination (DRE) findings. Traditionally, transrectal ultrasound (TRUS) guided biopsies have been the standard approach. However, CT guided prostate biopsy introduces a different imaging modality that enables enhanced visualization of the prostate anatomy and surrounding structures.

CT guided prostate biopsy involves the use of cross-sectional imaging from computed tomography scans to guide needle placement into suspicious lesions within the prostate gland. This imaging modality provides high-resolution, multiplanar views that facilitate accurate targeting of lesions, especially those difficult to detect or access via ultrasound. The procedure is typically performed under local anesthesia, with the patient positioned to optimize access to the prostate.

Technical Aspects and Procedure Workflow

The procedural workflow for CT guided prostate biopsy begins with acquiring a baseline CT scan of the pelvic region to identify suspicious areas within the prostate. Radiologists or interventional specialists then plan the optimal needle trajectory to minimize injury to adjacent tissues such as the rectum, bladder, or neurovascular bundles. Real-time or intermittent CT imaging assists in directing the biopsy needle precisely into the targeted lesion.

This method may employ coaxial biopsy needles to obtain multiple core samples during a single needle insertion, reducing patient discomfort and procedural time. The number of cores taken varies based on clinical suspicion, lesion size, and location but typically ranges from 6 to 12 samples.

Comparative Assessment: CT Guided Biopsy vs. Other Techniques

CT guided prostate biopsy is often compared with transrectal ultrasound (TRUS) guided and magnetic resonance imaging (MRI) guided biopsies, each with distinct advantages and limitations.

- **TRUS Guided Biopsy:** Most widely used due to accessibility and cost-effectiveness. However, TRUS has limited soft tissue contrast, which can hinder accurate lesion localization, leading to potential under-sampling of clinically significant cancers.
- **MRI Guided Biopsy:** Offers superior soft tissue contrast and functional imaging capabilities, enhancing lesion detection and characterization. MRI fusion biopsies combine MRI with real-time ultrasound to improve accuracy but require specialized equipment and expertise.
- **CT Guided Biopsy:** Provides excellent anatomical detail and is particularly useful when MRI is contraindicated or unavailable. CT guidance allows for precise needle placement and may be preferred for lesions not clearly visible on ultrasound.

While MRI guided biopsy generally offers superior sensitivity for detecting significant prostate cancers, CT guided biopsy remains a valuable tool, especially in settings lacking MRI resources or for patients with MRI contraindications such as implanted devices or claustrophobia.

Advantages of CT Guided Prostate Biopsy

CT guided prostate biopsy presents several clinical benefits:

1. **Enhanced Visualization:** CT imaging delivers detailed cross-sectional views, facilitating accurate targeting of lesions within the prostate and adjacent tissues.
2. **Minimized Sampling Errors:** Precise needle guidance reduces the risk of missing clinically significant cancers, potentially improving diagnostic yield.
3. **Reduced Risk of Complications:** By planning needle trajectories carefully, CT guidance can help avoid damage to critical structures, lowering the incidence of bleeding or infection.
4. **Accessibility and Speed:** CT scanners are widely available in many healthcare settings, allowing for relatively quick procedure scheduling and execution.

Limitations and Considerations

Despite its benefits, CT guided prostate biopsy also has drawbacks that merit consideration:

- **Radiation Exposure:** CT involves ionizing radiation, which raises concerns over cumulative exposure, especially for patients requiring multiple biopsies or imaging studies.
- **Soft Tissue Contrast Limitations:** Compared to MRI, CT offers less differentiation between prostate zones and tumor tissue, which may limit lesion characterization.
- **Potential for Discomfort:** The procedure may require repositioning and multiple needle insertions, which can cause discomfort despite local anesthesia.
- **Cost and Resource Utilization:** Although CT scanners are common, the procedure requires skilled radiologists and may incur higher costs relative to TRUS biopsies.

Clinical Indications and Patient Selection

CT guided prostate biopsy is particularly indicated in specific clinical scenarios, including:

- Patients with elevated PSA levels and negative or inconclusive TRUS biopsies.
- Lesions poorly visualized on ultrasound but detectable on CT imaging.
- Patients with contraindications to MRI, such as those with pacemakers or metallic implants.
- Cases requiring targeted biopsy of anterior prostate lesions or other anatomically challenging areas.

Careful patient selection is crucial to optimize diagnostic accuracy and minimize procedural risks. Multidisciplinary collaboration between urologists, radiologists, and oncologists is essential to determine the most appropriate biopsy approach tailored to individual patient factors.

Post-Procedure Care and Outcomes

Following CT guided prostate biopsy, patients are typically monitored for immediate complications such as bleeding, infection, or urinary retention. Prophylactic antibiotics are commonly administered to reduce infection risk. Most patients experience minimal discomfort and can resume normal activities within a day or two.

Histopathological analysis of biopsy cores determines the presence, grade, and extent of prostate cancer, guiding therapeutic decisions ranging from active surveillance to definitive treatment modalities like surgery or radiation.

Emerging data suggests that targeted biopsy techniques, including CT guided approaches, may improve the detection of clinically significant prostate cancers while reducing the diagnosis of indolent tumors, thereby refining patient management strategies.

Future Directions and Technological Innovations

Advancements in imaging technology and biopsy techniques continue to influence the role of CT guided prostate biopsy. Hybrid imaging modalities combining CT with PET (positron emission tomography) offer potential for enhanced lesion detection based on metabolic activity. Additionally, integration of artificial intelligence and machine learning algorithms may improve lesion identification and needle trajectory planning.

Efforts to reduce radiation dose through iterative reconstruction techniques and low-dose CT protocols aim to mitigate safety concerns. Furthermore, development of robotic-assisted biopsy systems promises increased precision and reproducibility.

As research progresses, CT guided prostate biopsy may become part of a multimodal diagnostic framework, complementing MRI and ultrasound to deliver personalized and accurate prostate cancer diagnostics.

In summary, CT guided prostate biopsy occupies a meaningful niche in prostate cancer diagnosis. Its

ability to provide precise lesion targeting under detailed anatomical visualization makes it a valuable option, particularly in complex or resource-limited clinical settings. Ongoing innovation and comparative studies will further clarify its role amid evolving prostate imaging and biopsy technologies.

Ct Guided Prostate Biopsy

ct guided prostate biopsy: Percutaneous Image-Guided Biopsy Kamran Ahrar, Sanjay Gupta, 2013-10-22 This book provides a comprehensive source for all aspects of percutaneous image-guided biopsy. A synthesis of rationale, technique and evidence-based medicine, it offers a clear approach to imaging, devices, procedures and patient care. Replete with case studies, radiological images, illustrative diagrams and tables, this valuable reference is an indispensable addition to the bookshelves of all radiologists in training as well as practicing radiologists who would like to expand their biopsy service and refine their skills. The easy to follow format, organization and graphic presentations create a high-yield approach to practical information such as indications, technical considerations, anatomical considerations, outcomes and complications. This timely compendium is a necessity in this rapidly progressing field.

ct guided prostate biopsy: Image-Guided and Adaptive Radiation Therapy Robert D. Timmerman, Lei Xing, 2012-10-09 This book provides detailed, state-of-the-art information and guidelines on the latest developments, innovations, and clinical procedures in image-guided and adaptive radiation therapy. The first section discusses key methodological and technological issues in image-guided and adaptive radiation therapy, including use of implanted fiducial markers, management of respiratory motion, image-guided stereotactic radiosurgery and stereotactic body radiation therapy, three-dimensional conformal brachytherapy, target definition and localization, and PET/CT and biologically conformal radiation therapy. The second section provides practical clinical information on image-guided adaptive radiation therapy for cancers at all common anatomic sites and for pediatric cancers. The third section offers practical guidelines for establishing an effective image-guided adaptive radiation therapy program.

ct guided prostate biopsy: Interventional Radiology Procedures in Biopsy and Drainage Debra A. Gervais, Tarun Sabharwal, 2010-11-02 The Techniques in Interventional Radiology series of handbooks describes in detail the various interventional radiology procedures and therapies that are in current practice. The series comprises four titles, which in turn cover procedures in angioplasty and stenting, transcatheter embolization and therapy, biopsy and drainage and ablation. Forthcoming are volumes on pediatric interventional radiology and neurointerventional radiology. Each book is laid out in bullet point format, so that the desired information can be located quickly and easily. Interventional radiologists at all stages, from trainees through to specialists, will find this book a valuable asset for their practice. Interventional Radiology Procedures in Biopsy and Drainage presents the full array of operations using these techniques. The book is split into two sections - one dedicated to biopsy procedures and the other to drainage procedures. Dr. Debra Gervais is Director of Pediatric Imaging and Associate Director of Abdominal Imaging and Intervention at Massachusetts General Hospital, Boston, Massachusetts, USA. Dr. Tarun Sabharwal is a Consultant Interventional Radiologist at Guy's and St Thomas' Hospital, London, UK.

ct guided prostate biopsy: Clinical and Translational Science David Robertson, Gordon H. Williams, 2016-11-25 Clinical and Translational Science: Principles of Human Research, Second Edition, is the most authoritative and timely resource for the broad range of investigators taking on the challenge of clinical and translational science, a field that is devoted to investigating human health and disease, interventions, and outcomes for the purposes of developing new treatment approaches, devices, and modalities to improve health. This updated second edition has been

prepared with an international perspective, beginning with fundamental principles, experimental design, epidemiology, traditional and new biostatistical approaches, and investigative tools. It presents complete instruction and guidance from fundamental principles, approaches, and infrastructure, especially for human genetics and genomics, human pharmacology, research in special populations, the societal context of human research, and the future of human research. The book moves on to discuss legal, social, and ethical issues, and concludes with a discussion of future prospects, providing readers with a comprehensive view of this rapidly developing area of science. Introduces novel physiological and therapeutic strategies for engaging the fastest growing scientific field in both the private sector and academic medicine Brings insights from international leaders into the discipline of clinical and translational science Addresses drug discovery, drug repurposing and development, innovative and improved approaches to go/no-go decisions in drug development, and traditional and innovative clinical trial designs

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ct guided prostate biopsy: *Handbook of Urologic Cryoablation* Daniel Rukstalis, Aaron E. Katz, 2007-02-13 As prostate cancer is the most common type of cancer found in men, the clinical and surgical commitments to treating it are enormous, as well as to be expected given the aging male population. Urologic cryotherapy is one such method for those with organ-confined or minimally-spread prostate cancer. The benefits it offers both patient and surgeon are

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ct guided prostate biopsy: *Vascular and Interventional Radiology: The Requisites*

E-Book John A. Kaufman, Michael J. Lee, 2013-08-19 Get the essential tools you need to make an accurate diagnosis with *Vascular and Interventional Radiology: The Requisites!* This bestselling volume delivers the conceptual, factual, and interpretive information you need for effective clinical practice in vascular and interventional radiology, as well certification and recertification review. Master core knowledge the easy and affordable way with clear, concise text enhanced by at-a-glance illustrations, boxes, and tables – all completely rewritten to bring you up to date with today's state of the art in vascular and interventional radiology. - Understand the basics with a comprehensive yet manageable review of the principles and practice of vascular and interventional radiology. Whether you're a resident preparing for exams or a practitioner needing a quick-consult source of information, *Vascular and Interventional Radiology* is your guide to the field. - Master the latest techniques for liver-directed cancer interventions; arterial and venous interventions including stroke therapy; thoracic duct embolization; peripheral arterial interventions; venous interventions for thrombosis and reflux; percutaneous ablation procedures; and much more. - Prepare for the written board exam and for clinical practice with critical information on interventional techniques and procedures. - Clearly visualize the findings you're likely to see in practice and on exams with vibrant full-color images and new vascular chapter images. - Access the complete, fully searchable text and downloadable images online with Expert Consult.

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the boards. This highly respected text enhances your understanding of general/abdominal and obstetric/gynecologic sonography, the two primary divisions of sonography, as well as vascular sonography and echocardiography. Each chapter covers patient history; normal anatomy, including cross-sectional anatomy; sonography techniques; pathology; and related laboratory findings. And more than 3,100 images and anatomy drawings guide you in recognizing normal anatomy and abnormal pathology. - Full-color presentation, including color scans of gross pathology photos, where appropriate, enhances your learning experience and the teaching value of the text. - Pathology tables give you quick access to clinical findings, laboratory findings, sonography findings, and differential considerations. - Pedagogy, including chapter objectives and outlines, alerts you to the important information you will learn in each chapter. - Evolve site includes PowerPoint slides, an image bank, review questions and a workbook answer key for students, and a test bank for faculty to aid in the reinforcement and teaching of sonography skills. - Sonography Findings, highlighted with icon and special type, call attention to key clinical information. - NEW! Full coverage of general/abdominal, transplantation, superficial structures, pediatrics, fetal heart, and obstetric/gynecologic sonography, along with several new chapters on vascular sonography, hemodynamics, and introduction to echocardiography, provides you with the information needed to pass the boards and succeed in clinicals. - UPDATED! Content reflects the newest curriculum standards so you have the information you need to pass the boards. - NEW! Updated images depict the latest advances in the field of sonography and help you prepare for the boards and clinicals. - NEW! Key words in chapter openers focus your attention on the terms that you are required to know and understand. - NEW! Bulleted summary lists at the end of each chapter reinforce important concepts. - NEW! A condensed bibliography at the end of the book lists essential references and guides you in the direction to obtain more information in a given area.

ct guided prostate biopsy: *Imaging in Oncological Urology* Jean J. M. C. H. Rosette, Michael J. Manyak, Mukesh G. Harisinghani, Hessel Wijkstra, 2008-11-23

The past decade has seen dramatic advances in urology and imaging. These changes are evident in improvements in laparoscopic surgery as well as in the emergence of multidetector CT, with multiplanar reformatting and FDG-PET-CT as routine imaging methods. The new minimally invasive procedures often require more exacting imaging as the surgeon does not have the same visual field of view as was possible with open procedures. Thus, it is appropriate now to provide an update on imaging advances for the benefit of urologists and radiologists alike. The increasing number of innovative imaging approaches to urologic tumors including CT, MRI, PET, SPECT, and endoscopic imaging can be perplexing and lead to over- and underestimations of the capabilities of modern imaging on the part of those who interpret them and those who use the information they provide for patient management. There is a growing "expectations gap" between what is expected and what is possible that needs to be closed. While previous books have focused on the more common urologic tumors such as bladder, prostate, and kidney cancer, none has attempted a comprehensive review of the state of the art of imaging in most of the tumors involved in urologic oncology. *Imaging in Urologic Oncology* addresses these challenges. In the modern imaging department it is easy to forget how useful conventional plain radiography can be in urologic diagnosis. Much of our current understanding of urologic disease is based on the "classic appearance" on intravenous urograms, cystograms, or retrograde pyelograms. Therefore, conventional imaging provides the first "layer" in our understanding of urologic tumors. The next layer is cross-sectional imaging.

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Access and Intervention; The Use of Ultrasound in Musculoskeletal Interventions; Ultrasound and GPS Technology; High-Intensity Focused Ultrasound; Varicose Vein Ablation; Diagnosis and Intervention in the Venous Portal System; and Ultrasound Evaluation of Hepatic Artery Stenosis.

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