DOWNLOAD PDF RADIOLOGY OF THE URINARY SYSTEM

Chapter 1 : Veterinary Proceeding, NAVC calendrierdelascience.com: Imaging of the Urinary System | Vet

ultra sound of urinary system -cheap-good for screening -no ionizing radiation-good for telling CYST FROM SOLID (evaluation of tumors)-good for deleting MEDICAL RENAL DISEASE.

Your doctor can use imaging techniques to determine, for example, whether a urinary stone or an enlarged prostate is blocking urine flow. Imaging can also help clarify kidney diseases, tumors, urinary refluxâ€"backward flow of urineâ€"urinary tract infections, incomplete emptying, and small bladder capacity. What factors will my doctor consider before ordering tests? The first step in solving a urinary problem is to talk with your doctor. You will be asked about your general medical history, including any major illnesses or surgeries, so you should be prepared to give as many details as you can about the problem and when it started. You should mention all the medicines you take, both prescription and nonprescription, because they might be part of the problem. You should also talk about how much fluid you drink a day and whether the beverages you drink contain alcohol or caffeine. Why does the doctor choose one imaging technique instead of another? Your doctor will look at several factors to decide what imaging technique to use. Each has advantages and disadvantages. Convenience and cost-effectiveness are also factors. Doctors have used x-ray machines to diagnose diseases for about a century. X rays of the urinary tract can help highlight a kidney stone or tumor that could block the flow of urine and cause pain. An x ray can also show the size and shape of the prostate. Conventional x rays do involve some exposure to ionizing radiationâ€"radiation that is strong enough to damage some cells. Two x-ray procedures involve the use of contrast medium, which is a liquid that acts like a dye and shows the shape of the urinary tract as it passes through the tract. The radiologist takes a series of snapshots as the medium circulates through the blood and reaches the kidneys. The structure of the kidneys shows up clearly on the x rays as the contrast medium is filtered from the blood and passes through the kidneys to the ureters. The x-ray machine then captures a video of the contrast medium during urination. This procedure allows the doctor to see things such as whether urine is backing up into the ureters when it should be traveling the other way, down through the urethra, or whether urine outflow through the urethra is blocked. VCUG is often used with children who have recurrent infections to determine whether a defect in the urinary tract is causing the infections. It can also show blockages from an enlarged prostate in men or abnormal bladder position in women. In ultrasound, or sonography, a technician holds a device, called a transducer, that sends harmless sound waves into the body and catches them as they bounce back off the internal organs to create a picture on a monitor. Different angles make it possible to examine different organs. The gel allows the transducer to glide easily, and it improves the transmission of the signals. Transrectal ultrasoundâ€"Transrectal ultrasound is most often used to examine the prostate. The ultrasound image shows the size and shape of the prostate and any irregularity that might be a tumor. To determine whether an abnormal-looking area is in fact a tumor, the doctor can use the transducer and the ultrasound images to guide a biopsy needle to the suspected tumor. The needle collects a few pieces of prostate tissue for examination with a microscope. MRI machines use radio waves and magnets to produce detailed pictures of internal organs and tissues. No exposure to radiation occurs. With most MRI machines, the patient lies on a table that slides into a tunnel that may be open-ended or closed at one end. Some newer machines are designed to allow the patient to lie in a more open space. During an MRI, the patient is awake but must remain perfectly still while the images are being taken, usually only a few minutes. A sequence of images may be needed to create a detailed picture of the organ. During the sequencing, the patient will hear mechanical knocking and humming noises. Magnetic resonance angiogram MRA. It can show renal artery stenosis, which is a narrowing of vessels that causes poor blood flow to the kidney and can cause high blood pressure and lead to reduced kidney function and eventually to kidney failure. CT scans use a combination of x rays and computer technology to create three-dimensional images. CT scans can help identify stones in the urinary tract, infections, cysts, tumors, and traumatic injury to the kidneys and ureters. How do I prepare for an imaging examination? How you prepare will depend on the purpose of the examination and the type of equipment to be used. Your doctor needs to know if you have any allergies to foods or medications and if you have had any

recent illnesses or medical conditions. Your doctor may tell you not to eat or drink anything for 12 hours before the test. For some ultrasound examinations, however, you may be instructed to drink several glasses of water 2 hours before the examination so your bladder will be full. You may be given a laxative to clear the colon before the examination. If you are having a transrectal ultrasound, you will be given an enema about 4 hours before the examination. If you are having an MRI or MRA, talk with the technical staff about any implanted devicesâ€"such as heart pacemakers, intrauterine devices IUDs , hip replacements, and implanted ports for catheterizationâ€"that may have metal parts that will affect the images. Metal plates, pins, screws, and surgical staples, as well as any bullets or shrapnel you might have in your body, may cause a problem if they have been in place for less than 4 to 6 weeks. What are the test procedures like? Most procedures for imaging the urinary tract are performed as the patient lies on a table. For an IVP, dye is injected into a vein, and x-ray pictures are taken at 0, 5, 10, and 15 minutes to see the progression of the contrast medium through the kidneys and ureters. The dye makes the kidneys and urine visible on the x ray and shows any narrowing or blockage in the urinary tract. This procedure can help identify problems in the kidneys, ureters, or bladder that may have resulted from urine retention or backup. MRI and CT scans may also require injection of dye. You will be asked to lie still for minutes at a time as the equipment takes pictures from different angles. A computer puts the different views together to create a three-dimensional model of your urinary tract. Some patients find it uncomfortable to lie in the small imaging tunnel, and others find the equipment noises annoying or unsettling. Knowing what to expect helps make these aspects of the test less disturbing. VCUG is most often used to evaluate urinary problems in children. The doctor or nurse cleans the area around the urethra, inserts the tip of the catheter, and gently slides it up into the bladder. Contrast medium is slowly dripped into the bladder, by means of gravity, until the bladder is full. X-ray films are then made as the child urinates. For a transrectal ultrasound, the doctor or technician inserts a probe slightly larger than a pen into the rectum. The probe directs high-frequency sound waves at the prostate and the echo patterns form an image of the gland on a monitor. Although the image shows the size of the prostate and any irregularities, it cannot definitively identify tumors. To determine whether an abnormal-looking area is in fact a tumor, the doctor can use the probe and the ultrasound images to guide a biopsy needle to the area. For an abdominal ultrasound exam, a technician will apply gel to your abdomen and sweep a handheld transducer across the area to generate a picture of your urinary tract. Like the IVP, an abdominal ultrasound can show damage or abnormalities in the upper urinary tract. What should I do after the test? For most of these tests, you will be able to resume normal activity immediately afterward. If your test involved placing a catheter in the urethra, you may have some mild discomfort. Drinking an 8-ounce glass of water every 30 minutes for 2 hours should help. Also, you may be able to take a warm bath. Alternatively, holding a warm, damp washcloth over the urethral opening may relieve the discomfort. You may experience some discomfort after a transrectal ultrasound as well. A prostate biopsy may produce pain in the rectum and the perineumâ€"the area between the rectum and the scrotum. For catheterization or biopsy, your doctor will sometimes, but not always, give you an antibiotic to take for 1 or 2 days to prevent an infection. If you notice signs of infectionâ€"including chills, fever, or persistent pain when you urinateâ€"you should call your doctor at once. When will I get the results? Results for simple tests can be discussed with your doctor or nurse immediately after the test. Other results may take a few days. You will have the chance to ask questions about the results and possible treatments for your problem. The NIDDK has established a program to develop and test accurate, reproducible techniques to monitor the progression of polycystic kidney disease so that potential interventions can be evaluated. This program will apply the latest advances in imaging technology so that clinicians can use information about kidney size and the portion of the kidney occupied by cysts to determine how far the disease has progressed. For example, current state-of-the-art methods using MRI techniques with rapid image acquisition rates make possible high-resolution, three-dimensional images of the kidneys. Semiautomated image analysis can determine renal size and the location of cystic structures. MRI may also permit simultaneous estimation of kidney function.

Chapter 2 : Free Radiology Flashcards about Urinary System

The urinary system consists of the kidneys, ureter, bladder and urethra. With the exception of the urethra, this is equitable in both males and females. It spans the abdomen and pelvis, from the upper abdomen to the extreme pelvis, being inextri.

Urinary Tract Imaging What is the urinary tract? The urinary tract includes two kidneys, two ureters, a bladder, and a urethra. The kidneys are a pair of bean-shaped organs, each about the size of a fist and located below the ribs, one on each side of the spine, toward the middle of the back. The wastes and extra water make up the 1 to 2 quarts of urine an adult produces each day. Children produce less urine each day; the amount produced depends on their age. The urine travels from the kidneys down two narrow tubes called the ureters. The urine is then stored in a balloonlike organ called the bladder. When the bladder empties, urine flows out of the body through a tube called the urethra at the bottom of the bladder. Imaging techniques include conventional radiology, or x-rays; ultrasound; magnetic resonance imaging MRI ; computerized tomography CT scans; and radionuclide scans. Imaging helps the health care provider see the causes of medical problems. What problems could require imaging of the urinary tract? Imaging can help the health care provider find the cause of urinary retentionâ€"the inability to empty the bladder completely urinary frequencyâ€"urination eight or more times a day urinary urgencyâ€"the inability to delay urination urinary incontinenceâ€"the accidental loss of urine blockage of urine abdominal massâ€"swelling in a specific part of the abdomen pain in the groin or lower back blood in the urine high blood pressure kidney failure One symptom can have several possible causes. The health care provider can use imaging techniques to determine, for example, whether a urinary tract stone or an enlarged prostate is blocking urine flow. Imaging can help clarify kidney diseases, tumors, urinary tract infections UTIs , urinary retention, small bladder capacity, and urinary refluxâ€"the backward flow of urine. What steps does the health care provider take before ordering imaging tests? Before ordering imaging tests, the health care provider asks about specific urinary tract symptoms, when they began, and their frequency considers general medical history, including any major illnesses or surgeries may ask female patients whether pregnancy is suspected asks about medication useâ€"both prescription and over the counterâ€"the amount of fluid consumed each day, and the use of alcohol and caffeine performs a physical exam These steps help the health care provider determine the possible causes of the urinary tract problems and what to look for in an imaging test. What are the imaging techniques? Conventional Radiology X-ray machines have been used to diagnose diseases for about years. X-rays of the urinary tract can help highlight a kidney stone or tumor that could be blocking the flow of urine and causing pain. For men, an x-ray also shows the size and shape of the prostateâ€"a walnut-shaped gland that surrounds the urethra at the neck of the bladder and supplies fluid that goes into semen. Conventional x-rays do involve some exposure to ionizing radiationâ€"radiation that is strong enough to damage some cells. Two common x-ray procedures include the injection of a special dye, called contrast medium, which shows the shape of the urinary tract. An IVP is an x-ray of the urinary tract. The contrast medium also shows any blockage in the urinary tract. An IVP can help locate problems in the kidneys, ureters, or bladder that may be caused by urinary retention or reflux. A VCUG is an x-ray image of the bladder and urethra taken while the bladder is full and during urination, also called voiding. As the person lies on the x-ray table, a health care provider inserts the tip of a thin, flexible tube called a catheter through the urethra into the bladder. The bladder is filled with contrast medium to make it clearly visible on the x-ray images. The x-rays are taken from various angles while the bladder is full of contrast medium. The catheter is then removed and x-ray images are taken during urination. The technician is supervised by a radiologist while the images are taken. The radiologist then interprets the images. Anesthesia is not needed, but sedation may be used for some people. A VCUG can reveal abnormalities of the inside of the urethra and bladder and is usually used for children to detect vesicoureteral refluxâ€"the abnormal flow of urine from the bladder back into the upper urinary tract. A VCUG can also show whether the flow of urine is normal when the bladder empties, blockages from an enlarged prostate in men, and an abnormal bladder position in women. Ultrasound Ultrasound uses a device, called a transducer, that bounces safe, painless sound

waves off organs to create an image of their structure. The transducer can be moved to different angles to make it possible to examine different organs. The images can be used to provide information that is valuable in diagnosing and treating a variety of diseases and conditions. The gel allows the transducer to glide easily, and it improves the transmission of the signals. An abdominal ultrasound can create images of the entire urinary tract. The images can show damage or abnormalities in the urinary tract. Transrectal ultrasound with prostate biopsy. Transrectal ultrasound is most often used to examine the prostate. The ultrasound image shows the size of the prostate and any abnormal-looking areas, such as tumors. Transrectal ultrasound cannot be used to definitively diagnose prostate cancer. To determine whether a tumor is cancerous, the health care provider performs a biopsy. For the biopsy, the health care provider uses the transducer and ultrasound images to guide a needle to the prostate. The needle is then used to remove a few pieces of prostate tissue for examination with a microscope. The biopsied prostate tissue is examined in a laboratory by a pathologistâ€”a doctor who specializes in diagnosing diseases. The biopsy can reveal whether prostate cancer is present. An MRI may include the injection of contrast medium. With most MRI machines, the person lies on a table that slides into a tunnel-shaped device where the images are taken. The device may be open ended or closed at one end; some newer machines are designed to allow the person to lie in a more open space. During an MRI, the person is usually awake but must remain perfectly still while the images are being taken. A sequence of images taken from different angles may be needed to create a detailed picture of the urinary tract. During the sequencing, the person will hear loud, mechanical knocking and humming noises. The procedure is performed in an outpatient center or hospital by a specially trained technician, and the images are interpreted by a radiologist; anesthesia is not needed, though light sedation may be used for people with a fear of confined spaces. An MRA is a type of MRI that provides the most detailed view of kidney arteriesâ€”the blood vessels that supply blood to the kidneys. An MRA can show kidney artery stenosis, which is the narrowing of a kidney artery that restricts blood flow to the kidney. Kidney artery stenosis can cause high blood pressure and lead to reduced kidney function and eventually kidney failure. CT Scans Computerized tomography scans use a combination of x-rays and computer technology to create three-dimensional 3-D images. A CT scan may include the injection of contrast medium. CT scans require the person to lie on a table that slides into a tunnel-shaped device where the x-rays are taken. The procedure is performed in an outpatient center or hospital by a specially trained technician, and the images are interpreted by a radiologist; anesthesia is not needed. CT scans can show stones in the urinary tract, obstructions, infections, cysts, tumors, and traumatic injuries. CT scan Radionuclide Scans A radionuclide scan is an imaging technique that relies on the detection of small amounts of radiation after injection of radioactive chemicals. Because the dose of the radioactive chemicals is small, the risk of causing damage to cells is low. Special cameras and computers are used to create images of the radioactive chemicals as they pass through the urinary tract. Radioactive chemicals injected into the blood can provide information about kidney function. Radioactive chemicals can also be put into the fluids used to fill the bladder and urethra for x-ray, MRI, and CT imaging. What preparations are needed for an imaging test? Preparations for an imaging test mostly depend on the purpose and type of test. In general, the health care provider will want to know whether the person is allergic to any foods or medications, is pregnant, or has had any recent illnesses or medical conditions. Specific preparations could include any of the following: What happens after imaging tests? After most imaging tests, the person can immediately resume normal activity. Tests that involved placing a catheter in the urethra may produce some mild discomfort for a few hours after the procedure. Drinking an 8-ounce glass of water every half-hour for 2 hours may help reduce the discomfort. The health care provider may recommend taking a warm bath or holding a warm, damp washcloth over the urethral opening to relieve the discomfort. A transrectal ultrasound may produce some discomfort. A prostate biopsy may produce pain in the area of the rectum and the perineum, which is between the rectum and the scrotum. A prostate biopsy may also produce blood in the urine and semen. For catheterization or biopsy, the health care provider may prescribe an antibiotic for 1 or 2 days to prevent an infection. People with signs of infectionâ€”including pain, chills, or feverâ€”should call a health care provider immediately. Some people have reactions to the contrast medium or the sedatives, though the risks are generally low. Signs of contrast medium reactions include hives, itching, nausea, vomiting, headache,

and dizziness. Contrast medium can cause kidney damage in people with certain conditions, such as impaired kidney function and diabetes. In most people, the kidney damage has no symptoms and goes away within a week or so. In rare cases, contrast medium causes lasting kidney damage. Signs of kidney damage include high blood pressure edemaâ€”swelling, usually in the hands, face, feet, or ankles tiredness.

Chapter 3 : Imaging of the urinary tract: the role of CT and MRI

The urinary system consists of two kidneys, two ureters, a urinary bladder, and a urethra. The urinary system forms urine to remove waste from the bloodstream for excretion. The urinary system forms urine to remove waste from the bloodstream for excretion.

Consider different contrast agent from one used previously X ray X rays utilize the difference in radiographic density of the various body parts to create an image or a radiograph. Traditionally these images were captured on X-ray film; however, nowadays we use the picture archiving and communication system PACS which is a film-less digital imaging system. The advantages of new technology are the improved resolution of the images and the ability to instantly and remotely share access to these images. The primary indications for plain radiographic imaging in pediatric urology are to visualize any radio-opaque objects in the GU tract or in the abdomen. Other uses are to evaluate the structure of the spine, evaluate for retroperitoneal air and fat-fascial planes, for evaluation of abscess, infection, and perforation. Plain films are also used in the evaluation of the position of stents or drains. Ultrasounds scan Ultrasound is usually the first line of investigations in suspected renal abnormalities. It is cheap, has no radiation and readily available. The disadvantage is that it is operator dependant. Upper-tract hydronephrosis should always be reevaluated when the bladder is empty to determine the degree to which a full bladder affects the dilation. This is the only way to differentiate between primary ureterovesical junction obstruction due to secondary upper tract dilatation and primary ureterovesical junction obstruction due to a bladder cause. The average newborn kidney is approximately 4. Although prenatal compensatory hypertrophy was not previously thought to occur, it has been observed in patients with solitary or multicystic dysplastic kidney, in whom the newborn contralateral kidney is larger than normal. The presence of cortical cysts and increased echogenicity, indicators of dysplasia and poor function, are useful signs when planning a pyeloplasty in a minimally functioning kidney. Nephrectomy should be considered in such patients. Useful in Kidney anatomy Size and shape Cortico-medullary differentiation- The kidney has a cortex the peripheral tissue and a medulla central to the cortex. On an ultrasound scan, the cortex should look whiter more echogenic than the medulla and thus, you should be able see and differentiate between these two different tissues judging by their color fig 1. In neonates, the renal cortex is isoechoic or hyperechoic relative to the liver. In the immediate newborn period, the renal pyramids may be echogenic with transient stasis nephropathy due to Tamm-Horsfall protein. In children, the renal pyramids are hypoechoic, which allows for clear observation of the corticomedullary junction. Loss of corticomedullary differentiation is what its called when both cortex and medulla are seen as the same shade of grey and one can not see any change of colour any change in shade of grey tones as most diagnostic images are black and white on the border of cortex and medulla. Diagnosis of kidney shape variants i. Screening of genetic conditions such as Beckwith-Wiedemann as there is a risk of developing renal tumours fig 4. Renal blood flow May or may not see renal calculi. Poor at looking for renal scarring. Bladder views both prevoid and postvoid should be included when evaluating the kidneys in children. Right kidney shows the differentiation between the cortex and medulla. Duplex collecting system with dilatation of both upper and lower moiety. Dilated left collecting system with the characteristic Mickey Mouse appearance suggestive of PU junction obstruction. Technique Those with catheter should have it clamped Bladder scanned first before remainder of abdomen to prevent early emptying of the bladder. Micturating cystourethrogram MCUG is a specialized radiology procedure that has an important role in the evaluation of the lower urinary tract in children. The incidence of diseases or disorders of the urinary tract of children is high and the ultrasound examination is not always clear. It requires aseptic bladder catheterization, a small feeding tube 8F for newborns, 10F for infants is passed via the urethra into the bladder. Contrast material is then instilled under fluoroscopic observation under gravity. Serial radiographs of the pelvis and abdomen are then taken. The first film obtained is important for the diagnosis of ureterocele. It is observed as a round filling defect at this point but may be compressed with further filling. The bladder is then filled until the expected capacity is reached. Tapping on the bladder or gentle massaging it is sometimes necessary to encourage the patient to void. Views of the kidneys and an oblique view of the male urethra are obtained once

voiding has started. Intrarenal reflux or reflux into compound papillae typically occurs at the poles of the kidney, which is a reason why the poles are more susceptible to infection and scarring. Indications Studying the urethra during micturation Bladder abnormalities.

Chapter 4 : Imaging of the urinary system

MCUG is a specialized radiology procedure that has an important role in the evaluation of the lower urinary tract in children. The incidence of diseases or disorders of the urinary tract of children is high and the ultrasound examination is not always clear.

Radiopaque stones and foreign bodies can also be seen. Nursing Responsibility Perform bowel preparation if ordered. The presence, position, size, and shape of the kidneys, ureters, and bladder can be evaluated. Cysts, tumors, lesions, and obstructions cause a distortion in the normal appearance of these structures. Patient with significantly decreased renal function should not have IVP because contrast media can be nephrotoxic and worsen renal function. Nursing Responsibility Evening before procedure, give cathartic or enema to empty colon of feces and gas. Keep patient on NPO status for 8 hr before procedure. Before procedure, assess patient for iodine sensitivity to avoid anaphylactic reaction. Inform patient that procedure involves lying on table and having serial e-rays taken. Advise the patient that warmth, a flushed face, and a salty taste during injection of contrast material may occur. After procedure, force fluids if permitted to flush out contrast material. Contrast medium may be injected percutaneously into the renal pelvis or via a nephrostomy tube that is already in place when determining tube function or ureteral integrity after trauma or surgery. Watch for signs of complications e. Test delineates segments of the kidney at different levels. Multiple exposures are taken to visualize specific sections of the kidney after IV injection of contrast material. It may be done if an IVP does not visualize the urinary tract or if the patient is allergic to the contrast material or has decreased renal function. A cystoscope is inserted and ureteral catheters are inserted through it into renal pelvis. Contrast material is injected through catheters. Inform patient that pain may be experienced from distention of pelvis discomfort from cystoscope. Inform patient that anesthesia may be given for procedure. Complications are similar tho those for cystoscopy. Findings can assist in diagnosing renal artery stenosis, additional or missing renal blood vessels, and renovascular hypertension. Can assist in differentiating between renal cyst and renal tumor. Renal arteriograms are also included in the workup of a potential renal transplant donor. A catheter is inserted into the femoral artery and passed up the aorta to the level of the renal arteries. Contrast medium is injected to outline the renal blood supply. Nursing Responsibility Prepare patient evening before procedure by giving cathartic or enema. Before injection of contrast material, test for iodine sensitivity. The patient may experience a transient warm feeling along the course of the blood vessel when the contrast material is injected. After procedure, place a pressure dressing over the femoral artery injection site. Observe the site for bleeding. Have patient maintain bed rest with the affected leg straight. Take peripheral pulses in the involved leg every min to detect occlusion of blood flow caused by a thrombus. Observe for complications, including thrombus, embolus, local inflammation, and hematoma. Conductive gel is applied to the skin. Noninvasive procedure involves passing sound waves into body structures and recording images as they are reflected back. Computer interprets tissue density based on Sound waves and displays it in picture form. Can be used safely in patients with renal failure. Nursing Responsibility Explain procedure to patient. Because radiation exposure is avoided, a number of images can be obtained and repeat studies can be done over a brief period of time. Images can be obtained from both the prone and supine positions. A bowel preparation is not required. Kidney size can be evaluated; tumors, abscesses, suprarenal masses e. Advantage of CT over ultrasound is its ability to distinguish subtle differences in density. Use of IV-administered contrast medium during CT accentuates density of renal tissue and helps differentiate masses. Ask patient about iodine sensitivity. The patient is instructed to lie very still during the procedure while the machine takes precise transaxial images. Sedation may be required if the patient is unable to cooperate. Not proven useful for detecting urinary calculi or calcified tumors. Computer-generated films rely on radiofrequency waves and alteration in magnetic field. Presence of implanted ferromagnetic clips or prosthesis, pacemaker, and some cardiac valves. Have patient remove all metal objects. Patients with a history of claustrophobia may need to be sedated. Gadolinium-enhanced studies allow visualization of the renal artery. Same as above Same as above. Does not require femoral artery puncture. Also used to evaluate patients with neurogenic bladder and recurrent urinary

tract infections. Can also delineate abnormalities of the bladder, such as diverticula, calculi, and tumors. Contrast material is instilled into bladder via cystoscopy or catheter. If done via cystoscopy, follow nursing care related to cystoscopy. When urethral trauma is suspected, a urethrogram is done before catheterization.

Chapter 5 : Diseases of the Urinary System | Radiology Key

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

References The advantages of multidetector CT urography over conventional plain film excretory urography also known as IV pyelography and IV urography and ultrasound for the evaluation of the urinary tract are numerous. Dedicated CT protocols have been developed for these new high speed machines for different clinical indications including "stone protocol" for the evaluation of urinary tract calculi, CT urography for the evaluation of patients with hematuria and "renal mass protocol" for the characterization of known renal masses. Multidetector CT scanning is fast, taking around 15 seconds for image acquisition from the kidneys to the bladder during a single breath-hold. The images have good spatial resolution, little mis-registration due to respiratory movement, and the acquisition of multiple thin slices allows excellent two- and three-dimensional reconstructions of the abdominal anatomy, making it possible to detect pathologies outside the urinary tract as well those within. Iodinated contrast agents are not usually required for the detection of renal stones, thus avoiding the risk of adverse reactions to these agents, but are routinely used in CT urography and the renal mass protocol. In comparison to CT, plain film excretory urography offers excellent delineation of calyceal and papillary anatomy, the ureters and bladder, but it is inferior to multi detector CT for imaging of the kidney parenchyma. Both CT and plain film excretory Three dimensional coronal reconstruction of CT urography image, showing contrast-enhanced renal collecting system, ureters, and bladder. Note duplicated system on left side. Ultrasound is good for imaging the kidney parenchyma and for detecting hydronephrosis, does not require the administration of iodinated contrast, and avoids radiation exposure. However, ultrasound is not good for detecting urinary tract calculi, and does not adequately image the renal collecting system or ureters. For these reasons, multidetector CT imaging has become the gold standard for the diagnosis of urinary tract calculi, the investigation of hematuria, and the characterization of renal masses and has largely replaced both plain film excretory urography and ultrasound examinations for these purposes. May be necessary infrequently to use iodinated contrast agent to distinguish between ureteral stones and phleboliths Follow-up imaging with non-contrast plain film radiography CT Urography Hematuria Protocol For evaluation for common causes of persistent hematuria, i. Urolithiasis and Nephrolithiasis Almost all ureteral and renal stones, including those containing uric acid, can be detected by non-contrast CT imaging. However, it is occasionally difficult to distinguish between non-obstructing distal ureteral calculi and pelvic phleboliths on non-contrast CT images. In these cases, it may be necessary to use intravenous contrast agent, so that the relationship of the calculus to the opacified ureter can be determined. Another situation in which intravenous contrast can be helpful is in the detection of stones in HIV positive patients on protease inhibitors such as Indinovir. These calculi are typically non-radio opaque and may go undetected on stone protocol CT scans. The use of 3-D reconstruction techniques of contrast-enhanced pyelographic phase images can be helpful in all of these situations. The disadvantage of "stone protocol" CT is that the radiation dose is high about mrem compared to that needed for plain film excretory urography about mrem and non-contrast plain film radiography about 13 mrem. This exposure is a significant concern, especially as urinary stones frequently affect young people. For this reason, it is better to avoid CT for follow up studies wherever possible and to use non-contrast plain film radiography instead. Pregnant patients should be evaluated initially with ultrasound imaging, to avoid exposure to any unnecessary radiation, and MR urography is an alternative imaging technique for evaluating the renal system in pregnant women, children, and patients with contraindications to contrast agents. Hematuria The main causes of hematuria are urinary tract calculi, renal tumors, urothelial tumors, and infection. CT urography is the best single diagnostic examination for diagnosing all of these pathologies, with the exception of infection, which is effectively diagnosed in most cases by microbiological analysis of the urine. CT urography requires the use of contrast agent to opacify the collecting system, the ureters, and the bladder. In addition to optimal opacification, distension appears to be an important requirement for thorough evaluation of the renal collecting

system and ureter. For this reason, intravenous saline is given at the same time as the contrast material to aid in the detection of subtle filling defects and the discrimination between urothelial neoplasms and other filling defects. Image reconstruction techniques are used to create images of the entire length of the urinary system from the kidneys to the bladder. Multi planar 3-D reconstruction can provide the anatomic detail required to correlate the finding with retrograde ureterography or to perform an endoscopic evaluation. Another potential advantage of CT is that reconstructed images can show tumors in a filled bladder opacified with contrast agent "virtual cytoscopy". However, conventional cytoscopy remains the gold standard for the detection of tumors of the bladder, as it will detect early color-changing mucosal lesions that do not deform the contour of the bladder wall. In addition, cytoscopy has the added capability of biopsy of suspicious lesions. Axial CT urography image showing a filling defect in the right renal pelvis consistent with a large urothelial tumor. Renal masses Many renal lesions are incidentally detected on a variety of imaging tests, but cannot usually be characterized at the time of detection. Currently, at this institution "renal-mass protocol" CT is the gold standard for the characterization of renal masses. This protocol acquires thin section images of the kidneys before and after intravenous contrast administration to evaluate the important characteristic of solid lesions, the unequivocal demonstration of lesion enhancement post contrast. Lesions that demonstrate unequivocal enhancement require histologic diagnosis either by image-guided biopsy or by surgical resection. Scheduling Further Information CT imaging of the urinary system has essentially replaced conventional plain film excretory urography at MGH. The appropriate CT protocol will be selected by the radiologist based on the clinical history of the patient. Results are made available to physicians online within hours. For further questions on CT urography, contact Dr. Radiol Clin North Am. Applications to CT Urography. American Family Physician Am J Roentgenol

Chapter 6 : Radiology of the Urinary System | JAMA | JAMA Network

These two volumes on radiology of the urinary tract represent a presentation of the experience of the author and his numerous contributors on the various radiological appearances of diseases of the urinary tract from the viewpoint of the practicing radiologist.

However, their imaging capabilities, while overlapping in some respects, should be considered as complementary, as each technique offers specific advantages and disadvantages both in actual inherent qualities of the technique and in specific patients and with a specific diagnostic question. For the scope of this article, the advantages and disadvantages of these techniques in children will be considered; different considerations will apply in adult practice. Magnetic resonance imaging, Computed tomography, Ultrasonography, Child, Kidney, Urinary tract, Diagnostic imaging Introduction Computed tomography CT was invented by Sir Godfrey Hounsfield and was introduced into medical practice in [1 â€” 3]. A computer then takes input from the X-rays at various angles to create an image of the object in slices, hence the name computed tomography. CT is therefore an X-ray technique and uses ionizing radiation. X-rays whether conventional, plain radiographs or CT give pictorial information on the density of an object or material. A CT image is therefore a pictorial demonstration of all the densities in the object, with high-density material bone, calcium, metalwork being represented as white and low-density materials being dark grey or black air, fat. Their density can be measured in Hounsfield units HU , and this can give the radiologist important information about the type of material or tissue. This has great advantages in children, as for the most part, children will not need to have a general anesthetic to ensure they keep still. This allows for very detailed information that can be reconstructed in other planes, such as sagittal and coronal projections, which are often very helpful to the physician in understanding the image. Three dimensional 3D images can also be produced in postprocessing, allowing rotating visualization of any part of the image that is required. CT provides a high spatial resolution image the ability to distinguish two structures an arbitrarily small distance from each other as separate with low noise, giving exquisite anatomical depiction, but it cannot give as much information with respect to processes within different tissues types, such as inflammation or necrosis, unless these are quite pronounced. The use of intravenously administered contrast medium helps in this respect and would be given routinely unless the main clinical question was regarding calcification or high-density objects such as when looking for renal calculi. There is almost no indication in children for doing both pre- and postcontrast scans as part of the same examination. The only occasion for routinely performing a precontrast unenhanced scan is when evaluating calculi, and if the examination is solely for that purpose, then there is no indication to routinely perform a postcontrast scan as well. Conversely, if there is no diagnostic concern regarding calculi, then only a postcontrast scan should be performed, as there is so little additional diagnostic yield if any from doing both a pre- and postcontrast scan, and the significant radiation dose from the additional precontrast scan cannot be justified. All patients should be asked for any history of contrast allergy or other severe allergies before contrast is given intravenously IV. Contrast is always most safely administered in the setting of good effective volume and hydration. Moreover, in the setting of a depressed glomerular filtration rate GFR , consideration should be given to both hydration and alkalinization and, in some instances, there may be a role for the use of postcontrast dialysis. Planning for imaging children with depressed GFR is best accomplished in a multidisciplinary fashion, with input from both radiologist and nephrologist. Intravenously administered contrast must not be given in severe renal failure unless the patient will subsequently be dialyzed. In mild renal failure, a risk assessment based on the potential benefit of the examination must be performed by the clinician, and the patient must be well hydrated beforehand. CT is a high-radiation-dose technique and as such is used much more cautiously and infrequently in children than in adults, with children being many times more biosensitive to radiation than adults. Much effort is being made by pediatric radiologists to reduce radiation doses in children, especially in CT imaging, and information regarding this can be found at http: Consideration should be given to performing specialized imaging studies that are elective in nature in facilities with pediatric expertise and pediatric imaging protocols, if these are available. Magnetic resonance imaging MRI provides

much greater contrast between different soft tissues [4] than does CT, as it relies on obtaining a radiofrequency RF signal from alignment and subsequent relaxation of protons in hydrogen atoms in water in the body. Soft tissue throughout the body will have varying water contents depending on cell types and the processes going on in and around those cells e. An MR scanner uses a powerful magnetic field to align the nuclear magnetization of protons of hydrogen atoms in water intra- and extracellular , and RF fields are then applied to alter the alignment of this magnetization, causing hydrogen nuclei to produce a rotating magnetic field that is detectable by the scanner. When RF fields are reversed, the protons relax to their normal state and give off a tiny RF signal that is detected by the scanner and is used to construct the image. Different tissues return to their equilibrium state at different rates. By changing the parameters of the scan, this effect is used to create an image that depicts the different tissues by showing the contrast between them. In a typical MRI scan, several different pulse sequences are performed to best exploit the different signals between tissues and give the most information. The main advantage of MRI over CT is that it gives far better contrast resolution the ability to distinguish the differences between two arbitrarily similar but not identical tissues and thus its ability to demonstrate changes between normal and pathological tissues. Between five and ten sequences would usually be performed. MRI can produce images in any plane desired, and this is achieved by the radiographer or technician when setting up scan parameters. Sequences can be selected specifically to demonstrate particular qualities of tissues, such as water content. For example, with particular values of the echo time TE and the repetition time TR , which are basic parameters of image acquisition, a sequence may take on the property of T2 weighting. On a T2-weighted scan, water- and fluid-containing tissues are bright most modern T2 sequences are actually fast T2 sequences , and fat-containing tissues are dark. The reverse is true for T1-weighted images. Damaged tissue tends to develop edema, which makes a T2-weighted sequence sensitive for pathology and generally able to distinguish pathologic tissue from normal tissue. Heavily T2-weighted sequences are especially useful in the urinary tract, as water-containing structures are bright white, such as the collecting system and the bladder. MRI contrast agents are frequently used. Most common of these is gadolinium, which is given intravenously. These agents work by shortening the T1 or T2 relaxation time of protons nearby. Gadolinium is therefore of most benefit in T1-based sequences. A rare but severe complication of gadolinium use is nephrogenic systemic fibrosis NSF , which causes fibrosis in various tissues and organs. Patients with poor renal function are considered a greater risk of NSF, and therefore, gadolinium contrast agents must only be used with caution in these patients. Depressed GFR encompasses both acute and chronic kidney injury. As such, individuals with transient renal dysfunction should also be considered at risk, even though their usual GFR may be normal. Older children are usually able to cooperate, but if they are unable to remain still and limit any movement for this length of time, they may also require a general anesthetic. In imaging the urinary tract in children, the modality of choice for the initial examination will almost universally be ultrasound US. US is inexpensive, immediate, painless, requires no sedation or anesthetic, is widely available, and is radiation free. In children, the urinary tract is easily visualized, as usually children have less body fat than adults, and the kidneys and bladder are relatively superficial structures. Children should be scanned both supine and prone, and the posterior approach with the child lying prone often gives the best anatomical detail of the kidneys. US can be used to scan in any plane at the discretion of the operator, and whereas the technique is entirely operator dependent, most centers have staff with a high level of skill. In most pediatric centers, it is considered completely unacceptable to proceed to CT or MRI in routine practice unless US had already been performed and had been unable to fully answer the diagnostic question. Acute multiorgan trauma would be the main exception to this. It is common practice in adult medicine to perform a CT scan of the abdomen and pelvis as the first-line examination for renal colic. In children, the first-line examination, even in renal colic, should ideally be US on radiation dose risk vs. However, there is some variation in this practice between North America and Europe and on the availability of US expertise out of hours. Renal colic in children is much less common than in adults, even in children with known stone disease, and their stones pass more readily. It is less sensitive, however, in the ureters, which may be obscured by bowel and other pelvic structures, so in the context of a normal US and ongoing clinical features suggestive of calculi colicky pain, hematuria, known existing stone disease , CT may still be

indicated. US is the first-choice examination for all other pathologies relating to the kidney and urinary tract. The use of CT and MR for specific clinical indications Congenital conditions In pediatric practice, many congenital conditions of the urinary tract are demonstrated in utero on antenatal scans, whereas some are only detected in infancy or later due to subsequent complications. Both antenatally and postnatally, US remains the examination of choice in demonstrating kidney and urinary tract anatomy. Structural urinary tract anomalies include renal dysplasia, renal hypoplasia, renal aplasia, multicystic dysplastic kidney, pelviureteric junction obstruction, duplication anomalies, fusion anomalies, renal ectopia, ureteroceles, cystic kidney diseases, and posterior urethral valves. All of these may be demonstrated by US, with additional information being acquired in some cases by other modalities such as nuclear medicine imaging or fluoroscopy. MRI may subsequently be useful in these patients, as illustrated in Fig. Heavily T2-weighted sequences water-based sequences are very useful in demonstrating dilatation of the urinary tract secondary to congenital anomalies, such as duplex kidneys with dilated moieties and occult moieties in a previously undiagnosed duplex kidney [13] Fig.

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Chapter 9 : Radiology Rounds November - Urinary Tract Imaging

What is the urinary tract? The urinary tract is the body's drainage system for removing wastes and extra water. The urinary tract includes two kidneys, two ureters, a bladder, and a urethra. The kidneys are a pair of bean-shaped organs, each about the size of a fist and located below the ribs, one.