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Common Urinary System Pathologies
and the Roles of Imaging Modalities
for Diagnosis and Assessment
Radiologic Technology
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Anatomy and physiology of the urinary system

The urinary system is an intricate organ system that is responsible for collecting, transporting, storing, and expelling urine (Hickling, Sun, & Wu, 2015). The process of forming and expelling urine is to ensure that the body eliminates any metabolic produces and toxic waste that are normally generated in the kidneys. The constant urinary flow of the upper urinary tract in combination with the urine elimination process facilitated by the lower urinary tract plays a critical role in cleansing the body as well as the urinary tract.

When the urinary system is not eliminating urine, the urinary tract remains closed to avoid accessibility of microbes into the urinary tract that may cause infectious diseases (Hickling, Sun, & Wu, 2015). The urinary system is composed of the upper urinary tract and the lower urinary tract. The upper urinary tract is composed of the kidneys and ureters. The lower urinary tract is composed of the urethra and the bladder.

Upper urinary system

Kidneys

The urinary system has two kidneys that sit retroperitoneal at the level between the twelfth thoracic vertebra and the third lumbar vertebra (Kowalczyk, 2022). There is a notch on the medial surface of each kidney called the hilum. The hilum contains renal arteries and veins, lymphatics, and a nerve plexus. The kidneys also contain nephrons which are described as the functional units of the kidneys. Each kidney contains more than one million nephrons (Kowalczyk, 2022). The nephrons are responsible for urine production and each unit contains the glomerulus, a Bowman's capsule, and many tubules.

The process of urine production begins at the glomerulus which can be described as a cluster of capillaries. Blood flowing through the glomerulus is filtered and cleaned of any waste and is then transported to the Bowman's capsule. The blood leaves the Bowman's capsule through the tubules where urine production occurs (Kowalczyk, 2022). The collection of tubules from the nephron form together to create the renal pyramid. The renal pyramid then forms an opening at the renal papillae where the urine exits the kidney. The urine then travels through the minor and major calyces which fuse together to form the renal pelvis.

Ureters

The ureters are bilateral tubes that drains urine from the kidneys to the bladder through peristalsis and gravity (Kowalczyk, 2022). The ureters are typically 28 to 34 centimeters in length and are positioned posterolateral in the body. The ureters originate in the kidneys at the uteropelvic junction, or UPJ, attached to the renal pelvis (Hickling, Sun, & Wu, 2015). This junction is positioned posterior to the renal artery and vein and inferior to the psoas muscles. The ureters empty urine into the bladder obliquely at the ureterovesical junction or UVJ.

Lower urinary system

Urinary bladder

The bladder is described as a reservoir for urine before it is expelled from the body (Kowalczyk, 2022). The bladder is very muscular; however, it does have the capabilities to expand. The normal adult bladder can store up to 350 to 600 milliliters of urine.

The urge to urinate is usually initiated once the bladder reaches approximately 250 milliliters in volume (Kowalczyk, 2022). The uterovesical junction contain valves that prevent the backflow of urine back into the upper urinary system once it is expelled into the bladder. The bladder is positioned differently depending on the gender of the patient (Hickling, Sun, & Wu, 2015). The male bladder is positioned between the rectum and pubic symphysis and the female bladder is positioned between the rectum and the vagina and uterus.

Urethra

The urethra is a tube that originates from the bladder to the exterior of the body (Kowalczyk, 2022). The urethra does have two separate sphincters that urine travels through: internal and external sphincter. The length of the ureter varies from male to female. The male urethra ranges from 17.5 to 20 centimeters and the female urethra are usually 4 centimeters (Kowalczyk, 2022). The male urethra has four separate portions internal to external: the prostatic portion, the membranous portion, the bulbous portion, and the cavernous portion. The urinary meatus is the opening of the urethra to the exterior of the body (Kowalczyk, 2022). For females, there are three openings. The urethra is the most anterior opening following by the vagina and anus.

Clinical assessments and imaging modality considerations

Clinical findings and laboratory tests

Due to the use of intravenous contrast media during imaging procedures, technologists must pay close attention to patient risk factors as well as laboratory test values to assess the patient's renal function. These clinical indications determine the patient's risk for contraindications to the contrast agent administered.

Common risk factors for contrast administration are demographic information such as age. If the patient is over 60 years of age, then they are at greater risk for having an adverse reaction to the contrast media. Also, if the patient has a history of renal disease such as dialysis, renal cancer, or renal surgery, hypertension, or diabetes mellitus, the patient should not receive contrast media for the exam. The most common test performed prior to administering contrast media are Creatinine, BUN, GFR, and eGFR.

Creatinine

Creatinine is a waste product of creatine normally found in muscle tissue (Lewin, 2023). The muscles utilize creatine to make energy. The normal flow of creatinine travels in the blood through the kidneys where it is filtered in the glomerulus and exits the body via the urine. The purpose of the creatinine lab values is an effective way to identify the GFR which overall indicates renal function (Lewin, 2023). High levels of creatinine in the blood can provide indication that the kidneys are not functioning properly.

Average creatinine levels in the adult male are between 0.7 to 1.2 mg/dL and the average levels in the adult female are between 0.5 to 1.0 mg/dL. There are several causes for high levels of creatinine in the blood and low levels of creatinine in the blood. When a patient has high levels of creatinine in the blood, this lab value can be an indication of kidney disease, kidney obstruction, increased consumption of protein, intense exercise, and certain medications (Lewin, 2023). Low lab values of creatinine can be caused by low muscle mass and extreme weight loss. In imaging procedures, a patient who presents with a creatinine greater than 3 mg/dL should not receive contrast media during the imaging procedure (Kowalczyk, 2022). This elevated lab value puts the patient at greater risk for contraindications of the contrast media.

Blood urea nitrogen

The blood urea nitrogen (BUN) is a blood test that is used to measure the amount of urea nitrogen in the blood (Mayo Clinical Staff, 2023). High levels of urea nitrogen in the blood provides the clinical indication that the kidneys are not functioning properly. Blood urea nitrogen levels are influenced by urine flow and the production of urea which is a chemical waste product (Mayo Clinical Staff, 2023). Urea travels from the liver to the kidneys through the blood stream. Urea, in healthy kidneys, is filtered out by the glomerulus and expelled from the body in urine. Normally, patients with suspected renal impairment have high levels of creatinine, urea nitrogen, or both due to the glomerulus not filtering waste or the tubular system not functioning properly due to obstruction (Kowalczyk, 2022). Patients who have BUN lab values of 50 or higher are at greater risk for contraindications of contrast media.

Glomerular filtration rate

The glomerular filtration rate (GFR) is a laboratory blood test that assesses kidney functionality by estimating how much blood passes through the glomerulus each minute (National Institute of Health, 2023). The GFR is a complicated test to perform, and most providers utilize a GFR calculator. The lab value may be estimated, eGFR, and will require patient information such as the creatinine lab values, age, race, and gender (National Institute of Health, 2023). The eGFR is a simple test and it is utilized as the main lab value in imaging to determine the safety of contrast administration prior to an imaging procedure (Kowalczyk, 2022). The exact threshold for contraindications of contrast has not been determined; however, there is a greater risk of kidney injury associated with patients who have an eGFR of less than or equal to 30.

Imaging modalities for the urinary system

Diagnostic radiography

Diagnostic radiography is an imaging modality that utilizes ionizing radiation to create images of the body (Food and Drug Administration, 2023). Ionizing radiation is a form of radiation energy that can alter or cause damage to DNA and has cancer-associated risk with increased radiation dose. With diagnostic radiography, an X-ray beam is emitted from an imaging tube and directed toward the patient. Once the x-ray is passed through the body, the x-rays are either absorbed by the patient, scattered off the patient, or transmitted to the image receptor to capture the image (Food and Drug Administration, 2023). Once the x-ray reaches the image receptor, the image is then recorded and submitted for further processing by a computer. Since its discovery, diagnostic radiography has created major advances in healthcare. Its benefits include assistance with diagnosis of disease, support medical and surgical treatment, and guide medical personnel for insertion of catheters or remove clots and blockages.

The kidneys, ureters, and bladder, or KUB projection, is a radiographic projection that allows for visualization of the size and location of the kidneys (Kowalczyk, 2022). The image demonstrates the two kidneys fixed to the abdominal wall. The kidneys are positioned oblique to the abdominal plane. The left kidney typically sits higher than the right kidney due to the liver that is situated on the right side (Kowalczyk, 2022). The evaluation of the kidneys with diagnostic radiography is often limited due to the low contrast of the image associated with abdominal imaging. The kidneys are also hard to visualize due to the obstruction of the bowel and bowel contents. The KUB is also used for initial imaging prior to urinary studies such as intravenous urogram or intravenous pyelogram (Kowalczyk, 2022). Prior to getting these exams, the patient must follow preparation such as bowel preparation so the kidneys will not be obscured. Radiopaque calculi of kidneys, ureters, or bladder can also be visualized prior to the exams.

Sonography

Ultrasound or sonography is an imaging modality highly accepted for its low cost, availability, and ability to differentiate between cystic, solid, and complex tissues (Eisenberg & Johnson, Comprehensive Radiographic Pathology, 2021). Sonography is a noninvasive imaging technique that utilizes sound waves to produce an image. The sound waves are generated through an electrical stimulation of a specialized crystal located in the transducer. The sound waves will pass through the anatomy which decreases their intensity by varying amounts depending on the acoustic properties of the tissue (Eisenberg & Johnson, Comprehensive Radiographic Pathology, 2021). The transducer sends a signal and acts as a receiver to record echoes that bounce back from the body when the sound waves strike an area where two tissues have different acoustic properties. The manifested ultrasound image displays the intensity of the level of the echoes.

This noninvasive modality is very helpful for visualizing functioning and nonfunctioning disorders of the urinary system (Kowalczyk, 2022). Sonography, or ultrasound, has the ability to demonstrate the structures of the kidneys and renal pelvis without the use of contrast media or ionizing radiation. Sonography can also assess the size of the kidneys. This modality has been deemed the modality of choice for most renal disorders and to evaluate and assess patients who have undergone kidney transplantation (Kowalczyk, 2022). The benefits of ultrasound to patients post-operation for kidney transplantation is the ultrasound technology can be transported to the patient's bedside. The ultrasound also has several other beneficial applications such as aspiration or biopsy of renal masses and evaluating kidney stones, hydronephrosis, and renal cysts (Kowalczyk, 2022). Doppler ultrasound technology is also helpful in assessing blood flow in renal arteries and veins along with demonstrating renal artery stenosis.

Computed tomography

Computed tomography is an imaging modality that produces cross-sectional tomographic images by scanning slices of tissue at multiple angles (Eisenberg & Johnson, Comprehensive Radiographic Pathology, 2021). Once the scan is complete, the modality displays a reconstructed image in gray scale from those slices onto a monitor.

Computed tomography is highly sensitive to tissue densities which allows for radiographic densities to be visualized. For example, a head CT alone can differentiate between blood clots, white matter, grey matter, cerebrospinal fluid, cerebral edema, and neoplastic processes (Eisenberg & Johnson, Comprehensive Radiographic Pathology, 2021). To further enhance the visualization of anatomy - specifically vascular structures - the injection of contrast media is an integral part in CT imaging. Contrast media permits the visualized differentiation of vascular and nonvascular structures, identification of neoplastic processes and infectious processes.

Computed tomography has major advantages when visualizing the urinary system (Kowalczyk, 2022). This modality can detect small differences in densities between the tissues in the body. The modality can also visualize small lesions, and with the post-processing software, the anatomy of interest can be reconstructed and scanned in narrow intervals (Kowalczyk, 2022).

Kidneys can be visualized with or without contrast with computed tomography; but the shorter scan times are associated with this modality lead to a minimum amount of contrast media being needed so the urinary system can be visualized in various stages of contrast enhancement. Computed tomography is considered the modality of choice for bladder tumors, detecting retroperitoneal masses, and obstructive pathologies such as renal stone studies (Kowalczyk, 2022).

Magnetic resonance imaging

Magnetic resonance imaging has multiple advantages such as the ability to produce images in multiple planes without the use of ionizing radiation, adequate visualization of normal and abnormal anatomy without the interference of bone, and the capability to image in any plane needed for accurate imaging (Eisenberg & Johnson, Comprehensive Radiographic Pathology, 2021). It also has some disadvantages like the longer scan times, patient conditions such as claustrophobia, and the inability to image patients with internal devices such as aneurysm clips, vascular stents, and cardiac pacemakers.

Magnetic resonance imaging has greatly improved abdominal imaging with breath hold imaging sequences and bolus injection of contrast for enhancement (Kowalczyk, 2022). Contrast-enhanced MRI has the capability to obtain coronal images of the renal arteries in 20 seconds with the ability to rotate the anatomy for better visualization. This modality also has the ability to differentiate between fluid from a hemorrhage or infection (Kowalczyk, 2022). Abdominal images with this modality can be used to stage and assess bladder cancers and renal masses and it can be used to assess how extensive these masses appear. Based on American College of Radiology recommendations, magnetic resonance imaging is the modality of choice when demonstrating vascular anomalies such as thrombosis, aneurysms, and arteriovenous malformations (Kowalczyk, 2022). Pelvic MRI can be used for demonstrating vesicles and the prostate gland in men as well as detect masses in the urinary bladder.

Common imaging exams performed for the urinary system

Intravenous urogram

Intravenous urogram or IVU is an imaging procedure that is used to assess and visualize the urinary system (Kowalczyk, 2022). This procedure is performed by injecting contrast media, either by hand or bolus injection, and taking a serious of KUB images to watch the contrast move throughout the urinary system.

The first image is taken immediately following the injection of the contrast media. This image is taken during the nephrogram phase because the technologist can visualize the contrast media in the nephrons prior to the contrast moving to the calyces (Kowalczyk, 2022). Following the initial image, a series of KUB images will be performed on time intervals such as five-minute interval, 15-minute interval, and so on.

The final step is the post void KUB which demonstrates the decompression of the urinary tract after the bladder has been emptied. The IVU procedure has been largely replaced with computed tomography urogram which provides cross-sectional images of the urinary system before and after contrast injections (Kowalczyk, 2022). There are several clinical indications for the IVU procedures such as flank pain, calculus disease, suspected urinary obstruction, hematuria, hypertension, urinary tract infections, or renal carcinomas and/or congenital genitourinary anomalies or trauma.

Cystogram

The cystogram, or retrograde cystogram, is an imaging procedure to visualize the lower urinary tract (Kowalczyk, 2022). A catheter is inserted into the urinary bladder to facilitate the introduction of contrast media retrograde into the urinary tract. Once the contrast is introduced, the technologist will perform images at volume intervals. The final volume is when the patient feels the sensation of the bladder being full (Kowalczyk, 2022).

The imaging can be performed via diagnostic radiographs, fluoroscopy, or a combination of both modalities. The optimal projections for the best visualization of the bladder are an anteroposterior projection, left posterior oblique, right posterior oblique, and lateral. Vesicoureteral reflux, or VUR, is the most common indication for the performance of the cystogram procedure. VUR is the malfunction of the ureteral valve which allows infection into the kidneys via the ureters (Kowalczyk, 2022). Cystograms can also be utilized to assess congenital bladder anomalies, tumors, diverticula, calculi, bladder urinary retention, and neurogenic bladder. This procedure can also be performed postoperatively to evaluate anatomy after kidney transplantation or to detect bladder injury after abdominopelvic surgery or cesarean sections.

Retrograde pyelography

Retrograde pyelogram is an exam performed to visualize the renal collecting system (Kowalczyk, 2022). The procedure is deemed retrograde due to the contrast media being injected directly into the ureters of the affected kidney in the opposite direction of the urine flow. The exam is normally performed by a urologist during an intraoperative cystoscopy (Kowalczyk, 2022). Common indications for a retrograde pyelogram are hematuria, hydronephrosis, and the presence of a nonfunctioning kidney. Images can be obtained through diagnostic radiographs; however, due to this exam being performed in the operating room, mobile C-arm fluoroscopy is most common.

Renal angiogram

Renal angiography is one of the most invasive procedures to be performed to visualize the urinary system. The exam is performed by introducing a catheter peripherally into the femoral artery. The catheter is further advanced into the renal artery of interest or into the abdominal aorta superior to the renal arteries. The contrast media is introduced to highlight the vasculature in one or both kidneys.

Renal angiogram is indicated to further evaluate the arterial supply of a renal mass that is suspected to be malignant, to embolize blood flow to a renal mass, or to assess renal artery stenosis which can cause hypertension. It can also be utilized to assess vascular disorders such as aneurysms, thrombus, arteriovenous malformation, arteriovenous fistula, vasculitis, hemangioma, or congenital anomalies. Renal angiography can also be utilized on kidney donors before surgical kidney removal to serve as a map of vascular anatomy for the surgeon.

Congenital and hereditary diseases

Congenital and hereditary pathologies of the kidneys and ureters are due to errors in the development of these anatomical structures (Kowalczyk, 2022). These pathologies can be classified as anomalies of number, size, form, fusion, and position. Approximately 10 percent of people have a congenital malformation of the urinary system which leads to impaired renal function (Kowalczyk, 2022). The impairment of the renal system can lead to infection and stone formation. Surgical intervention may be required to correct these congenital anomalies.

Number and size anomalies of the kidney

Renal agenesis

Renal agenesis, or aplasia, is a rare anomaly that may be associated with other congenital malformations (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Renal agenesis occurs in approximately one in 1000 live births and is more common in males than females (Kowalczyk, 2022). The cause of this pathology is the failure of the renal vascular system to fully develop and can demonstrate the absence of renal tissue (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Renal agenesis can be detected through renal sonography and manifests on the images as absence of a kidney on one side and an unusually large kidney on the other side (Kowalczyk, 2022). The larger kidney demonstrates a pathology called compensatory hypertrophy. Compensatory hypertrophy is when the solitary kidney tends to be larger than the typical kidney (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This condition is caused because the one kidney is forced to perform the functions of two kidneys. Before a diagnosis of renal agenesis can be made, the presence of a nonfunctioning kidney as well as any prior nephrectomy must be ruled out.

Bilateral agenesis

The absence of both kidneys is termed bilateral agenesis (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This pathology is significantly rare and occurs in one in every 3000 live births and is more common in male infants. Almost half of the infants born with bilateral agenesis are stillborn, or, if born alive, they die within four hours after birth (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Bilateral agenesis has also been associated with Potter syndrome. Potter Syndrome is a congenital disorder that is normally characterized by physical changes in neonates (Bhandari, Thada, & Sergent, 2022). Potter syndrome, like bilateral agenesis, is incompatible with life and the infant typically dies within an hour after birth due to respiratory distress.

Supernumerary kidney

A supernumerary kidney is a small third kidney in addition to the normal two kidneys (Kumar, Kumar, Barwal, & Raina, 2019). This kidney is a result of the abnormal division of the nephrogenic cord and may present with partially or completely duplicated ureters. The supernumerary kidney has its own separate arterial supply, venous drainage, and pelvicalyceal system.

This anomaly is typically seen on the left side and it is very rare to see a right-sided supernumerary kidney (Kumar, Kumar, Barwal, & Raina, 2019). This anomaly is typically asymptomatic but if an infection is present, a patient may present with fever, hypertension, abdominal discomfort, or a palpable mass may be present. Treatment for the anomaly depends on the symptoms of the patient as a result of this pathology (Kumar, Kumar, Barwal, & Raina, 2019). Intravenous urography, ultrasound, computed tomography, and magnetic resonance imaging are imaging modalities to visualize and diagnose supernumerary kidney.

Fusion anomalies of the kidneys

Horseshoe kidney

Horseshoe kidney is classified as the most common fusion anomaly of the kidneys (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). With this anomaly, the kidneys are rotated, and the lower poles are joined by renal or connective tissue. The ureters arise from the kidneys from an anterior position instead of medially. This anomaly causes the renal pelvis of each kidney to appear enlarged which can lead to renal obstruction at the ureteral pelvic junction (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Horseshoe kidney normally presents between four to six weeks of development (Kirkpatrick & Leslie, 2023). Even though there is no clear genetic cause for horseshoe kidney, research states that the development of horseshoe kidney can be attributed to abnormal influx of nephrogenic cells, alterations in uterine environment, and structural factors. The incidence of horseshoe kidney occurs more frequently in men and patients who present with urinary disorders and chromosomal disorders (Kirkpatrick & Leslie, 2023).

This anomaly is mostly asymptomatic and often identified as an accidental finding. Most children with horseshoe kidney have chief complaints of abdominal pain or symptoms associated with urinary tract infection. Horseshoe kidneys can be identified with plain or abdominal imaging (Kirkpatrick & Leslie, 2023). Ultrasound and computed tomography can also be used to better visualize the pathology and observe renal vasculature and surrounding anatomy. CT can also be utilized to identify any stones present as well as renal blockages.

Ureterocele

Ureteroceles are cystic dilations of the distal ureters near the bladder (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Ureterocele are classified as birth defects that occur during the prenatal period and blocks urine flow (Cleveland Clinic, 2023). Ureterocele is a condition that affects the kidneys, ureters, and bladder and can cause swelling at the end of the affected ureter due to the blockage of urine. Ureteroceles are typically caused by the distal portion of the ureter where it enters the bladder does not develop properly during the neonatal stages.

Diagnosis, signs, and symptoms of ureterocele

Ureteroceles can be diagnosed during an ultrasound before birth (Cleveland Clinic, 2023). During the diagnostic ultrasound, the dilated ureter and swollen kidney can be visualized indicating the pathology. Ureteroceles are also diagnosed in patients ages two years or younger. Older children and adult patients often have clinical indications for ureterocele such as kidney stones or urinary tract infections (Cleveland Clinic, 2023).

Several tests may be performed to diagnose ureteroceles such as a voiding cystogram, renal scans, CT and MRI scans, and a urine test. Patients with ureterocele are often asymptomatic; however, if the patient develops a UTI they may develop certain symptoms such as painful urination, foul smelling urine, and pain or lump in abdominal area (Cleveland Clinic, 2023).

Imaging appearance of ureterocele

A ureterocele can be best visualized during an intravenous urogram procedure (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The extent and appearance of the pathology depends on the filling of the abnormality with contrast. With contrast media utilized, a ureterocele has a round appearance that is surrounded by a tin radiolucent halo. This halo is meant to represent the wall of the ureter and the bladder and has similarities to the head of a cobra (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). If a contrast media is not present, the ureterocele appears as a radiolucent mass with the bladder having an opaque appearance. Ultrasound is the modality of choice for this pathology for diagnosis and visualization purposes. On ultrasound imaging, the lesion appears as a round cyst-like structure within the bladder.

Treatment of ureterocele

Treatment for ureterocele typically revolves around preserving kidney function and reducing the risk of infection for the patient (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). If the treatment is identified during the prenatal period, treatment options may include antibiotics (Cleveland Clinic, 2023). A minor procedure called a ureterocele puncture can also be performed.

The ureterocele puncture involves inserting a small camera into the bladder through the urethra to puncture the ureterocele. This procedure is meant to allow drainage of the urine into the bladder (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Aggressive treatment options are available for older patients such as surgical removal of the ureterocele with bladder reconstruction.

Inflammatory diseases

Urinary tract infections

Urinary tract infection, or UTI, is one of the most common bacterial infections (Kowalczyk, 2022). Urinary tract infections are infections of the urinary tract including the urethra, bladder, and kidneys (Braun, 2021). Due to women having shorter urethras than men, women have increased risk of contracting a urinary tract infection.

Urinary tract infections occur four times more frequently in females than males (Bono, Leslie, & Reygaert, 2022). Urinary tract infections are caused by the organism Escherichia coli. One main risk factor for UTIs is urinary catheterization. Sexual intercourse and forms of birth control such as spermicides and diaphragms are also contributing risk factors for UTIs.

Cystitis

Cystitis can be a result of a urinary tract infection (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Cystitis is inflammation of the urinary bladder. Similar to urinary tract infections, women have an increased risk of contracting cystitis due to their shorter urethras. The cause of cystitis depends on the type such as infectious or non-infectious (Katti, 2023). Infectious cystitis is caused by a bacterial infection where bacteria from fecal material reaches the urinary opening and progress toward the bladder (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Non-infectious cystitis is caused by foreign bodies such as catheterization for long periods of time and/or chemical cystitis is caused by items such as female hygiene sprays, bubble baths, and spermicidal creams (Katti, 2023). Risk factors for cystitis include sexual activity, hormonal changes, bladder stones, enlarged prostate, prolonged use of catheters, and weak immune system.

Diagnosis, signs, and symptoms of UTIs and cystitis

In order to diagnosis cystitis and urinary tract infections, the healthcare provider must gather a history of symptoms in combination with a physical exam (Braun, 2021). The healthcare provider may also order a urine test and gather urine cultures to check for white blood cells, red blood cells, bacteria, and other materials to diagnose the pathology. Clinical signs and symptoms for UTIs and cystitis include pain or pressure in the lower abdominopelvic area, pain or burning sensation while urinating, and increased frequency or urge to urinate (Braun, 2021). The patient may also have dark or foul smelling urine, blood in the urine, and an overall feeling of tiredness.

Treatment of UTIs and cystitis

Mild cases of cystitis can be managed without any medical intervention, and they typically resolve on their own (Braun, 2021). Healthcare providers normally advise drinking plenty of water, limiting caffeine intake, abstaining from sexual intercourse, limiting alcohol consumption, and applying a heat compress to relieve symptoms. Over-the-counter medications such as Tylenol or Advil can help reduce pain and discomfort associated with this pathology (Braun, 2021). If a bacterial infection is present, the patient will be given antibiotics.

Since urinary tract infections are bacterial infections, antibiotics will have to be utilized during the treatment process (Braun, 2021). During treatment, the patient will be advised to stay hydrated, limit caffeine intake, limit alcohol consumption, utilize a heat compress, and to take over-the-counter pain relievers. Severe infections may require hospitalization and extensive treatment to include the administration of intravenous antibiotics (Braun, 2021). If fever, vomiting, or pain in the back or sides become present, the patient could have a more severe infection.

Pyelonephritis

Pyelonephritis is the most common renal disease and can be characterized as an inflammatory disease of the kidneys and renal pelvis caused by pus-forming bacteria (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The inflammatory process associated with this pathology often affects the tissue between the tubules and the infection only involves one kidney. However, both kidneys can be involved. This infection is spread from the bloodstream or lymphatics with the infection typically starting in the bladder and progressing retrograde through the ureters to involve the kidneys (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This pathology is typically seen in women and children. However, this pathology can develop in patients with urinary tract obstruction. This obstruction can cause blockage of the urine which initiates breeding grounds for infection.

Diagnosis, signs, and symptoms of pyelonephritis

Pyelonephritis is typically caused because of a urinary tract infection (Belyayeva M, 2022). Common signs and symptoms of this pathology include fever, abdomen pain, nausea, vomiting, painful urination, and increased frequency and urgency to urinate (Belyayeva M, 2022). In order to diagnose pyelonephritis, a combination of imaging and urine analysis may be performed. During the urine analysis, the physician will normally look for pyuria or large amounts of pus in the urine which is the most common finding in patients with pyelonephritis.

Abdominal computed tomography is utilized to visualize and potentially diagnose pyelonephritis (Belyayeva M, 2022). Computed tomography is not normally required, however, it may be suggested in patients with diabetes that are not controlled, complicated urinary tract infections, renal transplant patients, and immunocompromised patients. Ultrasound can also be utilized for its ability to be performed bedside, no radiation, and can reveal other renal abnormalities.

Radiographic appearance of pyelonephritis

When visualizing this pathology, an intravenous urogram is performed (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). With acute pyelonephritis, the urogram findings present normal. If abnormalities are present, the kidneys will appear enlarged on the side affected, delayed filling of the renal calyces, and decreased density of the contrast material.

Patients with chronic pyelonephritis demonstrate clubbing of the renal calyces on the urogram (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Computed tomography is the modality of choice for pyelonephritis due to the contrast of the image and its ability to demonstrate any abscesses that are present. Even though ultrasound can demonstrate abscesses, the contrast in the image is compromised with ultrasound imaging. However, both modalities have the ability to demonstrate hydronephrosis with indications of urinary tract obstruction (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Urinary tract obstruction is a predisposing factor for pyelonephritis.

Treatment of pyelonephritis

Antibiotics are the first line of treatment for pyelonephritis (Mayo Clinic Staff, 2022). The treatment of the infection is very important due to the infection's ability to destroy large amounts of renal tissue and can spread infection throughout the body (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Symptoms typically clear up within a few days of antibiotic treatment; however, the patient is advised to continue with treatment (Mayo Clinic Staff, 2022). The patient will also have to repeat urine test to confirm the infection has been cleared. For patients with severe kidney infections or pyelonephritis, hospitalization may be required. During the hospitalization, antibiotics and fluids are administered intravenously. The hospital stay for the patient depends on the severity of the infection (Mayo Clinic Staff, 2022). If there is a structural problem such as a misshapen urinary tract, surgical repair may become necessary.

Urinary calcifications

Urinary system calcifications, or kidney stones, are hard deposits made of minerals and salts. Urinary calcifications are typically found in the kidneys (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The causes for urinary calcifications vary but the main cause seems to reflect an underlying metabolic pathology such as hypercalcemia. Stones can also form when the urine becomes too concentrated with crystal-forming substances such as calcium, oxalate, and uric acid. These substances harden and stick together (Mayo Clinic Staff, 2022). Other causes include diet, excess body weight, and certain supplements and medications. Urinary stasis and infection are also contributing factors to causing calculi formation (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Risk factors for kidney stones include family history, dehydration, certain diets, obesity, digestive diseases or surgery, certain medical conditions or supplements and medications (Mayo Clinic Staff, 2022).

Diagnosis, signs, symptoms of urinary calcifications

In order to diagnose kidney stones, diagnostic tests and procedures will be ordered (Mayo Clinic Staff, 2022). The healthcare provider will order blood, testing patients with suspected kidney stones. The blood test will reveal the presence of too much calcium or uric acid in the blood. Blood tests also can monitor the health of the kidneys to assess other underlying medical conditions (Mayo Clinic Staff, 2022).

The healthcare providers will also perform a 24-hour urine collection test. This urine test will demonstrate the presence of stone-forming minerals or lack of stone preventing substances. A total of two urine tests may be requested over a period of two days (Mayo Clinic Staff, 2022). Abdominal x-rays and Computed tomography imaging may be performed to demonstrate the presence of kidney stones.

Most kidney stones are asymptomatic until they become trapped in the ureter (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Kidney stones trapped in the ureter can lead to partial obstruction which manifests as extreme pain that travels from the kidneys to the groin area. This obstruction can block the flow of urine and cause kidney swelling (Mayo Clinic Staff, 2022). Other symptoms include sharp pain in the side and back, pain in the abdominopelvic area, and pain or burning while urinating. The patient may also experience pink or brown urine, foul smelling urine, and a persistent urgency to urinate. Nausea, vomiting, fever, and chills are also associated with the presence of kidney stones (Mayo Clinic Staff, 2022).

Imaging appearance of urinary calcifications

Over 80 percent of symptomatic kidney stones appear radiopaque and can be visualized on plain abdominal radiographs (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Even though kidney stones can be visualized on plain radiographs, abdomen images often miss approximately 34 percent of calcifications due to the presence of the bowel which obscures the visibility of the stones.

Computed tomography is typically the modality of choice for kidney stones (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This modality best visualizes the calcifications due to its ability to demonstrate the calcifications without the superimposition of the bowel and other anatomy. This modality is also deemed safer and more effective than an intravenous urogram. CT can detect the presence of hydronephrosis and hydroureter that can be a result of obstruction and can assist with determining the type of stone present (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

When computed tomography is unavailable, intravenous urogram can be utilized. An intravenous urogram can be performed to detect invisible and more radiolucent stones. These stones will appear as filling defects. In patients with renal colic, the urogram will demonstrate dilation of the proximal ureter (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Treatment for urinary calcifications

The most effective way to treat urinary calcifications are preventative measures such as increased fluid intake and decreased intake of stone-forming substances (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Surgery may be necessary for larger stones; however, surgery is utilized as a last resort treatment due to the longer recovery period.

Chemolysis is a new procedure which consists of the introduction of medication into the urinary system via a catheter (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The medication is meant to dissolve the stones into smaller pieces to be excreted via urination. Lithotripsy is also another technique utilized to break up the kidney stones by using shock waves. The shock waves shatter the stones into sand-like particles to be excreted in the urine. Lithotripsy is a great technique that works well for stones in the kidneys or upper ureters (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). If the stone is present in the lower portion of the ureter, cystoscopy retrieval or ureteroscopy basket is recommended for stone removal or laser destruction of the stone.

Degenerative and metabolic disease

Acute renal failure

Acute renal failure, or kidney failure, is the rapid deterioration of kidney function (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). When the kidneys fail to function normally, they are unable to filter waste products from the blood (Mayo Clinic Staff, 2022). Loss of kidney function leads to loss of filtering ability, waste accumulation, and chemical imbalance.

Acute renal failure typically develops rapidly and is more common in people who are critically ill or patients who need intensive care. There are several causes of kidney failure including pre-existing kidney diseases such as glomerulonephritis, pyelonephritis, and hypertension (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Also, toxic agents such as antibiotics, contrast, anesthetic agents, heavy metals, and organic solvents can be attributed to the cause of renal failure. Acute renal failure is almost always a direct result of another medical condition (Mayo Clinic Staff, 2022). Certain risk factors include hospitalization, increased age, blockages in blood vessels, diabetes, hypertension, heart failure, kidney disease, liver diseases, and certain cancers and treatments.

Diagnosis, signs, and symptoms of renal failure

In order to diagnose renal failure, a series of tests and procedures may be recommended. Urine output measurement is a test that is utilized to measure the volume of urine produced within a 24-hour period to assist with determining the cause of kidney failure. A urine analysis may also be performed in order to discover existing abnormalities that will indicate kidney failure. Blood tests are also performed in order to demonstrate any rising levels of urea and creatinine which will excess kidney function. Ultrasound and computed tomography images are performed to visualize the kidneys. A sample of the kidney may also be taken to test in the lab.

Clinical manifestations of kidney failure are decreased urine output, swelling in legs, ankles or feet, shortness of breath, fatigue, confusion, nausea, and weakness (Mayo Clinic Staff, 2022). The patient can also experience an irregular heartbeat, chest pain, seizures, or coma in severe cases. Prerenal kidney failure can result in decreased blood flow to the kidneys, cardiac failure, or obstruction of both renal arteries (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Postrenal kidney failure can result in obstruction of urine output from both kidneys due to prostatic disease and obstruction of the neck of the bladder. Patients may also present with foul, fishy, or urine-like smelling breath.

Imaging appearance of renal failure

Ultrasound is the modality of choice when assessing kidney failure (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Ultrasound is the modality of choice for renal failure due to the fact that this modality does not need contrast to visualize the anatomy of interest and pathologies. Ultrasound assists with the assessment of renal size, demonstrating renal disease and is helpful in excluding the presence of hydronephrosis (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This modality can also demonstrate dilation of ureters and the renal pelvis as well as distinguish low blood volume due to heart failure. Doppler ultrasound studies also aid in visualization of any obstructions of the vessels.

Intravenous tomography can be utilized to assess renal size (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Enlarged kidneys are an indication of renal dysfunction. Tomography can also detect the presence of renal calcifications or hyperparathyroidism caused by renal disease that leads to postrenal failure. Intravenous urography can also help demonstrate bilateral renal enlargement (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Intravenous urography has been deemed unnecessary and potentially harmful due to the use of contrast material which can cause further damage to the kidneys.

Treatment of renal failure

In order to treat kidney failure, the patient must identify the illness that has caused the kidneys not to function properly (Mayo Clinic Staff, 2022). The treatment of predisposing conditions lessens the risk of renal failure becoming persistent or chronic (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). One treatment option is to increase the patient's fluid intake through intravenous fluids, or a diuretic may be given to increase urine output and reduce swelling of arms and legs (Mayo Clinic Staff, 2022). Medications may be administered to reduce and control blood potassium and restore blood calcium levels. Dialysis can be utilized to give the kidneys time to recover (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Also, dialysis can assist with removing toxins from the blood. Antibiotics can also be utilized to treat any infections present due to the increased risk of sepsis associated with renal failure.

Cysts and neoplastic diseases

Renal cysts

Renal cysts are fluid filled masses that form on or in the kidneys (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The cysts vary in size and can occur in multiple sites in one or both kidneys. Renal cysts can often be accompanied by impaired kidney function (Mayo Clinical Staff, 2022). These cysts are typically not cancerous, and they do not cause any issues or alter functionality of the kidneys.

The cause of renal cyst varies; however, they often occur on the kidney surface (Mayo Clinical Staff, 2022). The risk of simple kidney cysts increases with age, even though this pathology can occur at any age. This condition is also more common in men. Renal cysts can also lead to complications such as an infected cyst, burst cyst, or blocked urine flow. The cyst can potentially become infected which results in fever and pain for the patient (Mayo Clinical Staff, 2022). The cyst can also burst which causes severe pain in the back or the side and blood in the urine. Kidney swelling can also occur due to the blocked urine flow.

Diagnosis, signs and symptoms for renal cysts

The kidney function test is performed to diagnose renal cyst (Mayo Clinical Staff, 2022). The kidney function test includes testing a sample of blood to demonstrate if the cyst is affecting functionality. Imaging procedures such as MRI, CT, and ultrasound are performed to assist with the diagnosis of renal cyst. Imaging tests can assist with distinguishing whether a mass is a cyst or a tumor (Mayo Clinical Staff, 2022). This pathology typically does not cause symptoms; however, if the cyst becomes too large, some symptoms may manifest. These symptoms include dull pain in the back or side, fever, and upper stomach pain.

Imaging appearance for renal cysts

Ultrasound is the modality of choice when visualizing renal cysts (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Ultrasound is highly effective in order to distinguish the difference between fluid-filled cysts and solid mass lesions. With ultrasound, the fluid-filled cysts appear as echo-free structures with enhanced walls (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The solid masses appear echo-filled with no enhancement of walls. Computed tomography is also highly effective when detecting and visualizing renal cysts.

Treatment for renal cysts

If the cyst does not present with symptoms or does not impair kidney function, treatment may not be needed (Mayo Clinical Staff, 2022). Treatment is normally selected once the cyst presents clinical manifestations. One treatment option is the draining of the cyst. The cyst is punctured and drained then filled with a solution to cause scarring to prevent refilling of the cyst (Mayo Clinical Staff, 2022). Another treatment option is surgical intervention. The cyst can be surgically removed by first draining the cyst of any fluid and then burning or cutting away the remaining cyst and its walls.

Renal carcinoma

Renal carcinoma is the most common malignant renal cell carcinoma or RCC (Kowalczyk, 2022). RCC is also known as hypernephroma. Renal carcinoma is considered an adenocarcinoma that stems from the renal tubules in the cortex of the kidney (Kowalczyk, 2022). Renal cell carcinoma occurs more frequently in males than females and the occurrence of this pathology increases with age. The cause of renal cell carcinoma is unknown; however, there are several risk factors associated with this pathology (Moawad, 2022). Some risk factors include inflammation from obstruction, cigarette smoking, obesity, and hypertension. Diabetes, obesity, and toxic chemicals are also contributing risk factors for renal cell carcinoma.

Diagnosis, signs and symptoms of renal carcinoma

In order to effectively diagnose renal cell carcinoma, the healthcare provider must utilize a mixture of methods to include full clinical evaluation, lab evaluations, and imaging (Gray & Harris, 2019). Clinical evaluations are performed with the use of chest and abdominal plain radiographs in addition to computed tomography, urography, and cystoscopy. These modalities aid with assessing malignancy. Urine analysis is performed to detect the present of pus or red blood cells in the urine which can be an indication of infection (Gray & Harris, 2019). Urine analysis can also help rule out any benign masses. CT is the modality of choice when diagnosing renal cell carcinoma. This modality detects 90 percent of renal masses and identifies any benign or malignant characteristics (Gray & Harris, 2019).

Symptoms vary as a result of renal cell carcinoma (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Due to the cancer starting in the kidneys, it has the ability to move to other parts of the body which presents a variation of symptoms. Many patients present with hematuria initially along with flank pain, fever, or palpable mass. Other symptoms include fatigue, blood in the urine, abdominal swelling, dizziness, and weight loss (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Kidney function can also be impaired and as a result specific signs can be presented. These signs are hypertension due to changes in hormone levels, a high level of red blood cells due to overproduction of erythropoietin, and anemia. Once the cancer spreads outside of the kidney, other symptoms may be present such as breathing problems, headaches and/or weakness, behavioral changes that include confusion or seizures (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

Imaging appearance of renal cell carcinoma

The imaging modality of choice is computed tomography (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). This modality is widely accepted because it demonstrates the density of the renal carcinoma in addition to assessing the degree of metastasis. On CT imaging, the renal mass presents as isodense to the kidney prior to the introduction of contrast media (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Once contrast media is introduced, the renal mass presents as hypodense to the kidney. If the tumor is malignant, the images will demonstrate the mass with irregular borders due to the necrosis that is presented inside the tumor (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The American College of Radiology recommends additional abdominal CT imaging with or without contrast for staging of the tumor and follow up assessment.

Treatment for renal cell carcinoma

One treatment option for renal cell carcinoma is surgical removal of the tumor (Gray & Harris, 2019). In order to successfully remove the tumor, the tumor must present as a solid mass and the tumor is nonmetastatic. In some patients, a partial nephrectomy is recommended with preservation of the nephron mass. If the patient presents with severe cancer risk and the mass extends beyond 3 cm in size, a radical nephrectomy is recommended (Gray & Harris, 2019). Other treatment options are thermal ablation, cryoablation and radiofrequency ablation of the tumor. Prior to these treatment options, the patient must undergo a renal biopsy to provide diagnosis and surveillance of the tumor. The last acceptable treatment option is active surveillance (Gray & Harris, 2019). Active surveillance should only be utilized with patients who have masses who are less than 2 cm in size. Active surveillance includes repeat imaging for three to six months and renal mass biopsy.

Bladder carcinoma

Cancer of the bladder or urothelial carcinoma is a carcinoma of the bladder that originates in the urothelial cells that line the inside of the bladder (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). Even though urothelial cells are found in the kidneys and ureters, carcinomas are commonly found in the bladder (Mayo Clinic Staff, 2022). Bladder cancer is commonly present in men older than 50 years of age. Bladder cancer is also the fourth most common cancer in men. The development of bladder carcinomas has been attributed to industrial chemicals and cigarette smoking (Mayo Clinic Staff, 2022). One cause is when cells in the bladder develop mutations in DNA. The mutated cells form a tumor that can destroy normal tissue and metastasize throughout the body.

There are three different types of bladder cancer (Mayo Clinic Staff, 2022). The first type, urothelial carcinoma, stems from the cells that line the bladder. These cells can expand, contracting the bladder when it is empty or full. Urothelial carcinoma is the most common type of bladder cancer (Mayo Clinic Staff, 2022). The second type is a squamous cell carcinoma. This type is associated with irritation of the bladder that stems from infection or long-term use of a catheter. This type is very rare in the United States (Mayo Clinic Staff, 2022). The third type is adenocarcinoma and stems from the cells that make up mucus secreting glands in the bladder. Adenocarcinoma is a very rare form of bladder cancer.

Diagnosis, signs and symptoms of bladder carcinoma

In order to diagnose bladder cancer, a series of tests and procedures are performed such as cystoscopy, biopsy, urine analysis, and imaging tests (Mayo Clinic Staff, 2022). Cystoscopy can be done in a doctor's office and consists of inserting a narrow tube through the urethra with a lens to allow visualization inside the urethra and bladder for indication of disease. During the cystoscopy, the physician will insert an instrument to collect a cell sample for testing (Mayo Clinic Staff, 2022). A urine sample is collected and analyzed under a microscope to detect any cancer cells. A CT urogram, or retrograde pyelogram, is also performed to examine the anatomy of the urinary tract.

Signs and symptoms associated with bladder cancer are hematuria which is the presence of blood in the urine (Mayo Clinic Staff, 2022). The blood will appear bright red or brown in color; however, urine can appear normal with the presence of blood detected through urine analysis. Some other symptoms include frequent and painful urination as well as back pain (Mayo Clinic Staff, 2022). Physicians suggest that if the urine becomes discolored, the patient should seek medical help immediately.

Imaging appearance for bladder carcinoma

Bladder cancer can be visualized with plain radiographs, intravenous urograms, computed tomography, and magnetic resonance imaging (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). On plain radiographs, the tumor inside the bladder may demonstrate finger-like projections or present with calcifications on the outside of the tumor or inside the tumor. On intravenous urograms, the cancer appears as polyp defects stemming from the bladder wall or bladder wall thickening is present (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021).

When CT is utilized for this pathology, the exam is performed with the bladder in full distention to better demonstrate the neoplasm in its entirety. CT can also be utilized when MRI is not available for staging of the malignancy and determining the full extent of the tumor (Eisenberg & Johnson, Chapter 6 The Urinary System, 2021). The modality of choice for bladder carcinoma is MRI. This modality can demonstrate the extent of the bladder wall invasion by the tumor with a high signal intensity.

Treatment of bladder carcinoma

Bladder cancer treatment depends on the type of cancer and grade and stage of cancer. One treatment option is surgical removal of the cancer cells or the removal of the bladder (Mayo Clinic Staff, 2022). The surgical removal could be in combination with chemotherapy of the bladder or the entire body.

Chemotherapy for the bladder is utilized to treat cancers that are confined to the bladder; however, chemotherapy for the whole body may be used if the tumor has metastasized, to increase chances for a cure, or as the primary treatment option (Mayo Clinic Staff, 2022). Radiation therapy is used to destroy the cancer cells of the bladder. Immunotherapy is a treatment option to indicate the body's immune system to fight cancer cells. Targeted therapy is used to treat advanced cancer when other treatment options have failed.

Conclusion

The purpose of this content is to describe the common pathologies associated with the urinary system as well as provide a brief overview of the system's anatomical components and the physiology of the system. The information is beneficial to imaging professionals and patients when selecting an adequate imaging modality that will provide the most accurate assessment and demonstration of common urinary pathologies. It can also help professionals to effectively utilize imaging as a guide to treat patient conditions and pathologies. By being more aware of the pathologic conditions of the urinary system, the imaging technologist can obtain a more detailed clinical history and can provide adequate identification of the pathologies present on the images.

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