Radiology in Urologic Patients

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S. A. Quallich, M. J. Lajiness (eds.), *The Nurse Practitioner in Urology*,
https://doi.org/10.1007/978-3-030-45267-4_21

Objectives

1. Explain common radiologic procedures and their indications in urology.
2. Review appropriate indications and patient preparation [as appropriate] for these studies.
3. Discuss benefits/risks associated with radiation exposure.
4. Determine appropriate radiation modality based on clinical concern, and specific advantages and limitations of each study.

Imaging in radiology is an important and integral part of urologic patient evaluation. Most urologic diseases will need confirmation by an appropriate radiology test. However, one should be alert to possible risks associated with radiation exposure. Radiation safety knowledge is important to balance risks/benefits associated with radiation exposure.

This chapter will act as a guide to choosing the correct diagnostic test modalities. Different imaging techniques are available and in this chapter, various modalities will be explored.

Plain Abdominal X-ray (KUB)

A simple plain film of the abdomen is a quick tool to help to visualize radiopaque calculi in the urinary tract. Currently, plain films are replaced by digital imaging in most of the locations. Radiation exposure is low and is about 0.53–0.7 millisieverts

(mSv) (ACR 2020). Radiation exposure is less with fluoroscopy when compared to conventional plain film.

Indications

1. Assess the presence of radiopaque calculi. Small or faint calculi may not be visualized especially if patient is constipated.
2. Visualize kidney shadow and other soft tissue shadows.
3. Assess bone for any abnormalities.
4. Assess patients with constipation and voiding dysfunction related to constipation.

Patient Preparation

1. No special preparation is needed in most patients.
2. Bowel preparation may be needed in patients with constipation.

Contraindications

1. Pregnancy

Basic Equipment and Techniques

- X-ray machine has several components. A high voltage power supply, an X-ray tube, a collimating device, an X-ray detector or film. In addition, an electronic image intensifier and an image display system for fluoroscopic machines. Most of the images are stored and displayed digitally.
- **Image Recording:** Conventional recording of an X-ray image uses film and intensifying screens. The image intensifier and camera can be used to capture dynamic and static images. Real-time images are now typically recorded using conventional or digital video. Conventional spot or cine images may be acquired on X-ray film or digitally recorded.

Intravenous Urogram (IVU)

Also known as excretory urography or intravenous pyelogram (IVP), IVU is used to evaluate the upper urinary tract for abnormalities. IVU is rarely used these days if CT scans or MRI are available since more information can be obtained. However, it can be used in certain circumstances especially if the information needed is not obtained from the CT scan. In some instances, it can be done in conjunction with a CT scan evaluation to help to obtain more information.

This study includes:

- A preliminary plain film of the abdomen,
- This is followed by IV contrast based on the body weight,
- Subsequent films at different time intervals to obtain a good image of the kidneys at the nephrogram phase followed by a good film at excretory phase. It requires about 4–6 films. This can be tailored to patient condition, preference, and clinical diagnosis. Radiation exposure is about 2.0–2.5 mSv.

Indications

IVU is widely replaced by other more sensitive cross imaging studies (CT or MRI) in most indications. They are rarely used except when the other images are not available (Ramchandani 2014).

1. Hematuria: It helps to evaluate both the renal parenchyma, the pelvicalyceal system, the ureters, and the urinary bladder.
2. Urinary calculi: IVU can help to identify the location of the stones and assess the urinary tract. It helps to assess the kidneys and help to diagnose obstruction.
3. Urothelial cancer: IVU can be used for surveillance in patients with urothelial cancer.
4. Recurrent urinary tract infections.
5. Evaluation of kidney lesions.
6. Urgent evaluation of renal trauma. In cases of renal trauma or intraoperative questions about urinary tract, an IV bolus of contrast material could be used. This will help to visualize kidneys and ureters as well as bladder. The proper dosing would be 2 mL/kg with a maximum of 150 mL. The film can be taken in 2–10 min after injection.

Proper Preparation Includes

- Exclude patients at risk of contrast allergies.
- Bowel cleansing is helpful but not mandatory.
- Proper hydration is important to avoid contrast material adverse events. Some advocate limiting fluid intake before the study to have a proper concentration of contrast material. If this technique is adopted, it should be used cautiously in patients with possible kidney diseases or chronic renal insufficiency.

Contraindications

- Pregnancy
- Allergy to contrast material. It is usually contraindicated to use contrast materials if there is history of adverse reaction to contrast material. This will be discussed separately. It is better to use other cross-sectional modalities if available.

Complications

- Allergic reactions
- Contrast material complication.

Retrograde Urogram (Retrograde Pyelogram, RP)

Retrograde urography is a minimally invasive procedure that is performed under sterile conditions where cystoscopy and fluoroscopy are needed.

Retrograde urograms may be necessary if excretory urograms or CT urogram (CTU) are unsatisfactory, if the patient has a history of adverse reaction to intravenous contrast media, or if other methods of imaging are unavailable or inappropriate.

This study includes:

- Cystoscopy for evaluation of the bladder and identifying the ureteric orifice.
- A radiopaque contrast medium is used at the proper concentration.
- A ureteral catheter (open tip or other types) is used to enable injection of the contrast into the ureter and the collecting system.
- Fluoroscopy machine.
- Form of anesthesia (general anesthesia or monitored anesthesia).

Indications

- Visualize the pelvicalyceal system and the ureters if they were not properly visualized on cross-sectional imaging.
- Allergy or contraindications to IV contrast material.
- Evaluate the level of urinary tract obstruction if CT scan or MRI is not informative/available.
- Evaluation of patients with hematuria if CT scan or MRI is contraindicated or more evaluation is needed.

Patient Preparation

- Obtain urine culture before the intervention to rule out the presence of active UTI.
- Caution should be exercised in patients with contrast allergy but it is not a contraindication to proceed.
- Proper assessment for general anesthesia.

Contraindications

- Active urinary tract infections
- Pregnancy

Complications

- Urinary tract infections and possible sepsis especially in patients with untreated active infections.
- Ureteral injury: can range from minor mucosal tear or ureteral perforation.
- Ureteral damage or avulsion: complete ureteral damage is a serious problem but extremely rare when all the ureter is damaged.
- Contrast extravasation which has no consequences but if extensive may require prolonged stent placement (usually 7–10 days).
- Allergic reaction although it is not a contraindication to the procedure but exercise caution during the procedure. Patients with contrast allergy may need to be premedicated reaction may occur if extensive contrast extravasation occurs during the procedure.

Antegrade Pyelography

It is a study where the pelvicalyceal system and ureter are visualized by injecting contrast material in an antegrade fashion through percutaneous access of the kidney.

This study includes:

- Accessing the kidney percutaneously using a percutaneous needle to inject the contrast material or using a preexisting renal tube (nephrostomy tube).
- Injecting contrast material through the needle or the nephrostomy tube.
- Using fluoroscopy.
- Taking pictures as needed.

Patient Preparation

- Obtain urine culture before intervention to rule out the presence of active UTI.
- Caution should be exercised in patients with contrast allergy but it is not a contraindication to proceed.
- Proper assessment for general anesthesia if needed.
- Hold anticoagulation therapy prior to attempt to access the kidney (discuss with PCP or cardiologist time frame).

Indications

- Visualize the upper tract when other images are not satisfactory.
- Evaluate the level of obstruction of the urinary tract if the whole ureter or portion of the ureter is not visualized through retrograde ureterogram.
- As a part of other surgeries.

Contraindications

- Active urinary tract infection.
- Uncontrolled coagulopathy.

Complications

- Injury to neighboring organs or structures during access.
- Bleeding.
- Sepsis in patients with active urinary tract infections.
- Urinary tract infections.
- Contrast extravasation which is not serious except in patients with contrast material allergy.

Voiding Cystourethrogram (VCUG)

The aim of this study is to visualize the anatomy of the urinary bladder and the urethra during voiding. This will allow the visualization of the bladder and the urethra and identify anatomical and some functional abnormalities in the lower urinary tract.

This study includes:

- Inserting a urethral catheter into the bladder.
- A radiopaque contrast medium instilled into the bladder.
- Amount of dye should be about 300 cc or until the patient feels the urge to void.
- Fluoroscopy machine.
- Usually, no anesthesia is required.
- The patient is allowed to void while taking different pictures with fluoroscopy.

Indications

- Evaluation of possible anatomic abnormalities especially in pediatric population. Examples: Posterior urethral valve, vesicoureteral reflux especially in children with fever and recurrent urinary tract infections.
- Evaluation of possible causes of voiding dysfunction especially in patients with neurogenic bladder.
- Evaluation of some patients with urethral stricture.

Patient Preparation

- Obtain urine culture prior to intervention to rule out the presence of active UTI
- Caution should be exercised in patients with contrast allergy but it not a contraindication to proceed.

Contraindications

- Active urinary tract infections.
- Recent bladder surgery is a relative contraindication.

Complications

- Urinary tract infection.
- Dysuria.
- Minimal bleeding may occur after the procedure.

Retrograde Urethrogram (RUG)

The aim of this study is to visualize the anatomy of the urethra in male patients. This usually helps to visualize the anterior urethra since the posterior urethra is usually difficult to visualize because of the competent external urethral sphincter.

This study includes:

- Inserting a urethral catheter into the tip of the urethra and inflate the balloon with about 2 mL of water. This will allow the balloon to settle in the fossa navicularis.
- A radiopaque contrast medium injected into the urethra. A high-pressure injection should be avoided to avoid extravasation of contrast.
- Fluoroscopy machine to take appropriate pictures. Films should be done in anteroposterior and oblique views.
- Usually, no anesthesia is required.

Indications

- Assessment of the urethra in case of suspected urethral trauma. Consider in patients who present with blood drop at the urethral meatus after trauma.
- Evaluation of patients with known or suspected urethral stricture disease.
- Visualization of the urethra in case of suspected urethral disease such as urethra diverticula or fistula.

Patient Preparation

- Obtain urine culture prior to intervention to rule out the presence of active UTI.
- Caution should be exercised in patients with contrast allergy but it is not a contraindication to proceed.

Contraindications

- Active urinary tract infection.
- Caution should be adopted in patients with contrast allergy. Consider premedication.

Complications

- Urinary tract infection.
- Dysuria.
- Minimal bleeding may occur after the procedure.

Renal Nuclear Scan (Radionuclide Imaging)

The aim of this study is to assess kidney function, perfusion and/or obstruction using nuclear scans (Ramchandani 2014).

This study includes:

- A specific radioactive isotope tracer, injected IV.
- Gamma camera to capture the tracer.
- Many images are obtained depending on the type of information needed.
- A diuretic such as furosemide may be given at certain time to help with assessment of renal obstruction.

Indications

- Assessment of glomerular filtration rate (GFR). This will help to obtain information about split renal function.
- Evaluation of kidney obstruction.
- Evaluation of patients with kidney transplant to rule out the presence of obstruction, lack of perfusion from renal artery stenosis, presence of renal tubular necrosis or rejection.
- May be used to follow up of patients with vesicoureteral reflux (VUR).
- Evaluation of patients with acute scrotum. It helps to rule out testicular hypoperfusion secondary to torsion.
- In PET scans.

Patient Preparation

- No specific patient preparation is needed.
- Patients should have an empty bladder. A Foley catheter may be inserted in some patients during the study to ensure empty bladder.

Contraindications

- Active urinary tract infection.

Complications

1. Urinary tract infection.
2. Dysuria.
3. Minimal bleeding may occur after the procedure.

Angiography

It is the study where the contrast material is injected to visualize the arterial and venous system. This may be requested in urology patients in certain conditions.

Indications (Bishoff and Art 2016)

- Renal artery stenosis if suspected from clinical history. However, this is largely replaced by CT angiography or MR angiography.
- Preoperative evaluation for patients who may have arterial anomalies.
- Renal trauma, when vascular lesions are suspected.
- Postoperative bleeding if arterial injury or arteriovenous fistula are suspected?
- Adrenal gland tumors if adrenal vein sampling is desired.
- Varicocele: Patients with varicocele who would prefer embolization for treatment.

Complications

Complications after these procedures are rare and include but not limited to:

- Pain at the site of the puncture.
- Bleeding.
- Bruises at the site of the puncture.
- If embolization is used, it may lead to loss of the organ (very rare).
- Infection.

Contraindication

- Allergy to contrast material.
- Active infection at the site of injection.

Ultrasonography (US)

The most commonly utilized imaging modalities for urologic patients' evaluation. It has the advantages of being noninvasive with no radiation exposure and real-time evaluation. Gray-scale imaging allows for the evaluation of the anatomy and architecture structure of the organs while Doppler imaging allows to assess the vascularity and direction of blood flow in the organs and masses. Three-dimensional imaging allows for better quality evaluation. Different transducers are used based on the organs needed to be examined (Bishoff and Art 2016; Ramchandani 2014; Wieder 2014).

There are different probes that are used for the ultrasound examinations. It depends on the organ to be evaluated. There are also different frequencies of the probe. The lower the frequency of the probe, the deeper penetration of the tissues. For this reason, low-frequency probes such as 3–5 MHz are used for the kidneys. The high-frequency probes 6–7.5 MHz are usually used for the transvaginal or the transrectal ultrasound examinations. While higher frequency probes 7.5–10 MHz are usually used for more superficial tissues such as penile and scrotal evaluation (Wieder 2014).

Patient Preparation

1- There is not specific preparation needed.
2- It is possible to consider treatment of constipation prior to evaluation with US.
3- Good hydration may be helpful but not required.

Indications

Ultrasound has different utilization based on the organs needed to be evaluated. Different probes are used based on the organ and depth of penetration.

Kidneys

1. Kidney architecture and rule out obstruction.
2. Evaluation and surveillance of suspected kidney lesion or mass.
3. Assessment of kidney architecture in case of impaired renal function.
4. Evaluation of renal cysts.
5. Evaluation of rental transplant using Gray-scale and color Doppler.
6. Evaluation of perinephric collection.
7. Renal access for biopsy and procedures.
8. Intraoperative to help identifying kidney lesions during partial nephrectomy or ablation of lesions.
9. Antenatal kidney evaluation for hydronephrosis.
10. Evaluation of kidneys with unresolved infection to rule out the presence of renal abscess.
11. Monitoring renal abscess for improvement with treatment.

Urinary Bladder

1. Evaluation of the bladder for abnormalities such as stones, diverticula, or masses.
2. Measurement of residual urine.
3. Assess for the presence of urine efflux based on visualization of ureteral jets to rule out kidney obstruction (Wieder 2014).
4. Bladder access for procedure.

Prostate

1. Evaluation of the prostate and seminal vesicles.
2. Transrectal Ultrasound for evaluation of the prostate and other pelvic organs.
3. Transrectal US guided biopsy or aspiration of cysts.
4. Part of MRI fusion biopsy.

Scrotum (Ramchandani 2014)

1. Evaluation of scrotal and scrotal contents.
2. Evaluation of acute scrotum using color Doppler.
3. Undescended testis.
4. Assessment of cord lesions or varicocele.

Genital Evaluation

1. Evaluation of patients with erectile dysfunction using color Doppler.
2. Localizing plaques in patient with Peyronie disease.
3. Evaluation of patients with suspected penile fracture.
4. Pelvic or translabial US in women may help to identify anatomy and location or urethral diverticula and slings or mesh used for pelvic floor construction.

Complications

No complications.

Contraindications

There are no contraindications to using ultrasounds. It is a safe modality to use and it is good to consider for evaluation of pregnant women. However, it should be noted that interpretation of the US is operator dependents. Some difficulty may be encountered with patients who experience obesity or abnormal body habitus. Renal ultrasound will not visualize a stone in the ureters.

Computed Tomography (CT) Scan

A collimated X-ray beam that is taken in cross-sectional slices with variable thickness. Thickness can vary according to the indication for the study from 3 mm to 1 cm. It can be used with or without contrast depending on the organ and pathology

under evaluation. It is the most versatile and most common used modalities for evaluation of urologic disease (Ramchandani 2014). It is more informative and more accurate than IVU in diagnosis of upper urinary tract abnormalities.

Radiation exposure is higher than KUB. It is estimated to be approximately 4–14 mSv per study. This could increase with increasing CT scan studies by obtaining series. If a CT scan without contrast and then a CT scan with contrast are obtained then that exposure increases.

Patient Preparation

1. Proper hydration when the contrast material is used.
2. Caution should be exercised in patients with contrast allergy but it is not a contraindication to proceed.
3. Pregnancy test in sexually active women of child bearing age.

Indications

1. Evaluation and assessment of patients with urolithiasis.
2. Evaluation and staging of renal mass.
3. Surveillance of renal mass postoperatively.
4. Assessment of renal cyst.
5. Evaluation for urinary obstruction and causes of obstruction

Complications

1. Radiation exposure for a CT scan abdomen and pelvis is about 10 mSv while it is more with CT urogram. It is usually >1.5 times of the radiation exposure of IVU.
2. These related to contrast material.

Magnetic Resonance Imaging (MRI)

MRI is a valuable cross-sectional imaging for the evaluation of soft tissues. It has less radiation exposure and is a good alternative option in patients who are allergic to contrast materials. MRI can be used with or without contrast. Gadolinium is the contrast used.

Patient Preparation

1. Ensure that the patient does not have any metal implants in the body.
2. Patients who are known to have claustrophobia may not be candidates for this study and may require additional preparation.

Indications (Ramchandani 2014)

1. Evaluation of soft tissue mass.
2. Characterization of renal mass or cyst especially if other modalities are not conclusive.
3. The image of choice for visualization of venous thrombus associated with renal cancer.
4. Staging of cancer, especially if more information about soft tissue invasion is needed.
5. May help with the evaluation of urinary obstruction, however, it is not good for stones visualization.
6. Diagnosis of Pheochromocytoma which will appear bright on MRI.
7. Dynamic MRI may be helpful for evaluation of pelvic organ prolapse.
8. Multiparametric MRI is currently used for providing anatomic details about prostate cancer. It is used in conjunction with MRI fusion technology for prostate biopsy in selected patients.
9. It is the image of choice for evaluation of pelvic lesions such as urethral diverticulum.

Contraindications

- Patients with metal implants.
- Patients who have chronic renal insufficiency that may be predisposed to contrast reaction.

Complications

- Nephrogenic systemic sclerosis associated with using gadolinium contrast.

Contrast Materials

Contrast media is very important to understand. Often used frequently to visualize the urinary tract system, contrast media help to improve resolution and differentiation between different organs and structures. The extracellular distribution of these agents results in improved contrast resolution and conspicuity of various structures. It also may help in the differential diagnosis of pathologies in organs. It can help to differentiate between benign renal lesions and malignant lesions. It can help to identify different types of cysts.

Made of water-soluble iodinated compounds, contrast media when excreted form a radiopaque image. Primarily used in IVU, different interventional radiology procedures, and CT scans.

The contrast material can be injected directly intravenous (IV) in case of IVU and CT scans. It also could be instilled directly into the urinary tract. In interventional radiology procedures, the contrast material can be used in different ways. Direct instillation to the collecting system or bladders uses similar media diluted to 15–45% concentration. This technique can avoid the risks of intravenous contrast material. When instilled into the bladder (cystography or cystogram) helps to visualize the bladder and identify bladder pathology if done correctly. The collecting system and ureters could be visualized by directly injecting contrast material into the collecting system. It can be performed in an antegrade fashion through a nephrostomy tube or retrograde fashion using cystoscopy and ureteric catheters.

The contrast materials used in CT scan are of low osmolarity or iso-osmolarity which are better tolerated and have a less frequent adverse reaction when compared to high osmolarity contrast material. The regular dose of iodine is about 2 mL/kg bodyweight with a maximum of 150 mL.

Contraindications

- Chronic kidney insufficiency: Injecting contrast materials in patients with known renal insufficiency may add risks of deterioration of kidney function.
- Allergic reaction to contrast materials.
- Congestive heart failure (CHF): contrast material may add to the workload due to added osmotic load in patients with severe or uncontrolled CHF.
- Metformin: patients should stop the medication 24–48 h before the study and resume when kidney function is back to baseline about 48 h after contrast use. These patients rarely at risk of developing fatal lactic acidosis.

Complications

Contrast-Induced Nephrotoxicity

- Acute renal insufficiency in predisposed patients. In this situation, acute renal insufficiency may ensue and then return to its baseline within 14 days [3].
- To avoid this problem:
  - Patients should be well hydrated.
  - Avoid any nephrotoxic agents such as NSAID, ACE inhibitors, and diuretics within 24 h before the scan.
  - Consider using none–ionic low osmolality contrast material.

Adverse Reactions to Contrast Material

- **Predisposing conditions to contrast adverse reaction:**
  - Iodine allergy.
  - Renal insufficiency: This is the most important risk factor that should be looked for. It is associated with a higher risk of developing contrast-induced nephrotoxicity.

- History of asthma or diabetes.
- Severe cardiac disease and heart failure.
- Dehydration.
- Sickle cell anemia
- Hyperthyroidism.
- Adrenal pheochromocytoma.

- **Types of adverse reactions:**
  - These reactions are more common with high osmolar contrast materials and less common with low-osmolar or iso-osmolar contrast materials.
  - Anaphylaxis (idiosyncratic, anaphylactoid) (ACR 2020): This is a severe reaction that can occur without expectation. It is associated with severe anaphylaxis and could be fatal (Spring et al. 1997). These reactions are not dose dependent.
  - Non-idiosyncratic reactions: These are dose-dependent and are related to the osmolality, concentration, volume, and injection rate of contrast material (ACR 2020).
  - Symptoms of non-idiosyncratic reactions include (ACR 2020) Sever:
  - Mild reactions:

    Nausea, vomiting, cough, warmth, headache, dizziness, altered taste, itching, flushing, chills, sweats, rash and hives, nasal stiffness, swelling of the eyes, and increased anxiety.

    Treatment for this reaction usually requires reassurance and observation. Antiallergic H1 receptor blocker (diphenhydramine orally, intramuscular or IV 1–2 mg/kg up to 50 mg) may be used.
  - Moderate reactions:

    Tachycardia or bradycardia, dyspnea, pulmonary edema, hypertension or hypotension, bronchospasm, and laryngeal edema.

    Treatment and monitoring are necessary. Treatment depends on the symptoms and should consider hydrocortisone 100–500 mg IV or IM and B-agonist inhalation for bronchospasms.
  - Severe reactions:

    Severe laryngeal spasms, cardiopulmonary arrest, unresponsiveness, hypotension, convulsions, and arrhythmias.

    This is an emergency that requires prompt treatment with attention to proper management of cardiovascular and respiratory symptoms. Epinephrine, IV fluid, and oxygen are the treatment for this situation. Patients will need close monitoring.

Preparation of Patients with Contrast Allergy (Bishoff and Art 2016)

1. Antihistaminics (H1 or H2 blockers).
2. Steroids
3. Epinephrine

- Patients with high risk to contrast media severe adverse reactions should be premedicated. This premedication will not eliminate the risk of this reaction however it will help to control them.

- Strategies used include:
  - Using nonionic contrast media will help to reduce the risks, and
  - 50 mg p.o. at 13, 7, and 1 h before contrast media injection plus diphenhydramine 50 mg IV, IM or p.o. 1 h before contrast injection, OR
  - Methylprednisone (Medrol) 32 mg p.o. 12 and 2 h before contrast media injection plus diphenhydramine 50 mg IV, IM or p.o. 1 h before contrast injection.

Cautions in Using Contrast Material Should Be Exercised in These Patients

- Extra precautions should be considered in
  - Patients taking metformin as there is a risk of developing lactic acidosis. This may be fatal in 50% of patients with renal insufficiency.
  - Patients with chronic renal disease, DM and dehydration status as these may predispose to kidney damage secondary to contrast-induced nephropathy:

  Gadolinium is a contrast material that is used with the MRI scan.

- **Nephrogenic systemic sclerosis**
  - When renal function (GFR) is less than 30 mL/min.
  - Fibrosis of the skin, subcutaneous tissues, lungs, esophagus, heart, and skeletal muscles.
  - Initial symptoms can occur between 2 and 90 days.
  - Starts by swelling of the distal extremities and then induration of the skin.
  - Death may result in some patients.

Radiation Safety

Radiation safety protocols should be followed to limit the hazards as much as possible (Table 21.1). Aim of radiation safety is to keep radiation exposure "as low as reasonably achievable (ALARA)."

How to reduce radiation exposure?

These are important considerations to remember:

Table 21.1 Radiation exposure to different modalities

Diagnostic modality	Expected radiation exposure dose (mSv)
Chest X-ray (PA film)	0.02
Lumbar spine	1.5
I.V. urogram	3
Upper G.I. exam	6
CT head	2
CT chest	7
CT abdomen	8
Coronary CT angiogram	16

Adapted from McCollough CH, Bushberg JT, Fletcher JG, Eckel LJ (2015) Answers to Common Questions About the Use and Safety of CT Scans. Mayo Clin Proc 90 (10):1380–1392. https://doi.org/10.1016/j.mayocp.2015.07.011

1. Distance: increased distance decreases radiation exposure. Radiation exposure is inversely related to square distance.
2. Time: limiting the time of exposure as much as possible is important.
3. Shielding: Using proper shields to minimize radiation exposure is crucial.
4. Exposure to body parts should be limited.
5. Risks include the development of cataract and radiation-induced cancer.

"Radiation dose during fluoroscopy is directly proportional to the **time of exposure** and to the **number of exposures."**

One should not underestimate the effect of radiation exposure. The Food and Drug Administration (FDA) reported: "A CT examination with an effective dose of 10 mSv may be associated with an increase in the possibility of fatal cancer of approximately 1 chance in 2000." This issue raises concerns about the excessive use of CT scans. Some studies showed that a low dose (<3.5 mSv) and ultra-low dose CT scan (<1 mSv) may be helpful in the diagnosis of stones in patients in emergency department to reduce radiation exposure (Moore et al. 2016; Rodger et al. 2018) and avoid radiation exposure.

Clinical Pearls

- Confirm that list of patient allergies is current, to avoid contrast media reactions.
- When ordering imaging studies, consider the probable need for insurance prior authorization.
- Most GU imaging does not require patient preparation.
- For patients that have an extensive history of imaging or radiation used for treatment (e.g., stone or trauma patients) consider total radiation dose and consider a non-radiation test when appropriate.
- Always evaluate renal function prior to any exam that involves contrast media.
- Several factors impact an individual's risk from radiation exposure: age, gender, genetic factors, type of study, and the fractionation and protraction of the radiation.

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