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Advanced Medical Imaging Consultants, PC

Educational Newsletter

Benign Prostatic Hyperplasia (BPH) and Lower Urinary Tract Symptoms (LUTS): New Treatment Options with Prostate Artery Embolization

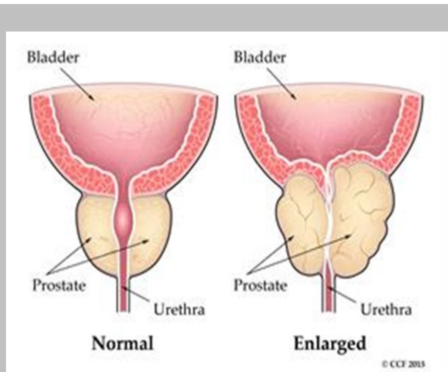
By Alistair Jordan, DO

Introduction:

Benign prostatic hyperplasia (BPH) is defined by proliferation of smooth muscle and epithelial cells in the transitional zone of the prostate causing gland enlargement and often resulting in lower urinary tract symptoms (LUTS). In men over 60 years of age, 50% have been diagnosed with BPH, and 75% of men over the age of 70 have 1 or more symptom attributable to BPH. By 85 years of age, 90% of men have symptoms of BPH (1). In 2000, BPH accounted for $1.1 billion in direct health-care expenditures, 4.4 million office visits, 117,000 emergency room visits, 105,000 hospitalizations and 21-38 million hours in lost productivity. The estimated annual costs of BPH treatment are at $4 billion (2).

Symptoms:

BPH and LUTS can present in a variety of ways including increased frequency of urination, excessive urination at night (nocturia) urgency, hesitancy, and weak urine stream. In the case of BPH, these symptoms are caused by prostate gland enlargement which causes problems with normal urine retention or voiding. Careful evaluation of patients with LUTS must be made to exclude other potential causes including prostatic carcinoma, urinary tract infection and neurogenic bladder.



BPH can significantly reduce the quality of life. The effect on quality of life is highly variable, and objective measures do not correlate well with the severity of symptoms. This has lead to the development of several assessment models the most common of which is by the American Urological Association-Symptom Index. A score of 0-7 is considered mild, 8-19 is moderate, and 20-35 is severe.

American Urological Association - Symptom Index

	Not at all	Less than 1 time in 5	Less than half the time	About half the time	More than half the time	Almost always
Over the past month how often have you had a sensation of not emptying your bladder completely after you finished urinating?	0	1	2	3	4	5
Over the past month, how often have you had to urinate again less than two hours after you finished urinating?	0	1	2	3	4	5
Over the past month, how often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5
Over the past month, how often have you found it difficult to postpone urination?	0	1	2	3	4	5
Over the past month, how often have you had a weak urinary stream?	0	1	2	3	4	5
	None	1 time	2 times	3 times	4 times	5 times
Over the past month, how many times did you most typically get up to urinate from the time you went to bed at night the time you got up in the morning?						

Treatment Options:

Medical therapy is a first-line treatment option and is indicated for patients with moderate lower urinary tract symptoms (3). Medical therapies for BPH relief include α-adrenergic blockers and 5α-reductase inhibitors. Medical therapy is indicated for patients with moderate lower urinary tract symptoms with no absolute indications for surgery (recurrent urinary retention, recurrent urinary tract infections, renal insufficiency, bladder calculi, and recurrent gross hematuria). Medical therapy, α-adrenergic blockers, and 5α-reductase inhibitors, even when combined with each other, have limited effectiveness in reducing urinary symptoms.

Those patients who are refractory to these treatments have been referred for transurethral resection of the prostate (TURP), which is currently the gold standard definitive treatment for BPH. However, this procedure does come with significant risks including bleeding and nerve damage potentially leading to impotence. As a result, alternative options have been explored, although a number of these new techniques have not been proven to be as effective as TURP.

A new, minimally invasive treatment option has emerged in the form of prostate artery embolization (PAE). The prostate receives blood supply from the prostatic arteries, which arise singly or paired on each pelvic side. Superselection and embolization of the prostatic arteries leads to ischemic necrosis of a large proportion of the gland. Shrinkage of the gland follows, with subsequent reduction of LUTS.

Work-up and Potential Candidates for Prostate Artery Embolization:

Several entities such as prostate cancer and neurogenic bladder need to be excluded prior to the procedure. Initial evaluation comprises an interventional radiology consult where a detailed medical history includes an International Prostate Symptom Score (IPSS), LUTS baseline history, current prostate medications, and history of sexual dysfunction through a questionnaire such as Sexual Health Inventory for Men (SHIM). Additional work-up will also consist of MRI imaging of the prostate, evaluation of urine flow rate through uroflowmetry and urine analysis to check for urinary tract infection.

Benign Prostatic Hyperplasia (BPH) and Lower Urinary Tract Symptoms (LUTS) continued…

Potential candidates for prostate artery embolization include:

- Men who do not want or are ineligible for surgery
- Men who have tried medication, but have found it to be ineffective or the side effect profile is too burdensome
- Men who want to avoid higher risk of potential adverse surgical events such as impotence, retrograde ejaculation, and urinary incontinence.

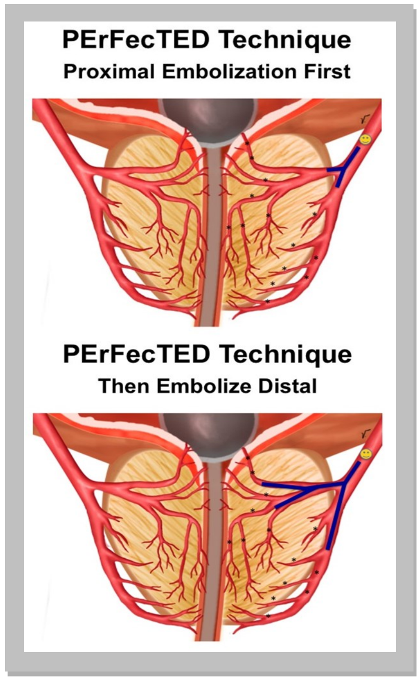
Procedure:

Prostate artery embolization is performed in the outpatient setting. Moderate sedation is utilized with procedure time ranging from 2-4 hours. A Foley catheter is placed. Access is typically from either the radial artery or via the right common femoral artery. Angiography is then performed for vascular mapping. A microcatheter is then advanced into the prostatic vasculature. Embolization is performed with small microspheres. At AMIC, we perform a Proximal Embolization First, Then Embolize Distal (PErFecTED Technique).

This method was developed by Dr. Carnevale and constitutes embolizing the prostatic artery to near stasis after passing all collateral arteries. Then the microcatheter is advanced deeper into the parenchymal branches, which are embolized to complete stasis. This is compared to original PAE, in which the prostatic artery is embolized to stasis after passing all collateral arteries, without advancement into each parenchymal prostatic artery branch. This technique has produced greater prostate ischemia and infarction than previously described methods with clinical improvement of lower urinary symptoms and lower recurrence rates (3).

Advantages of Prostate Artery Embolization:

PAE has several potential advantages over traditional surgical therapies. It is minimally invasive, usually performed via a single femoral or radial artery puncture. Conscious sedation is used rather than general anesthesia. The procedure is well tolerated without significant pain. Technical success is defined as embolization of at least one prostatic side and is achieved in greater than 95% of patients. Bilateral embolization is the preferred definition of technical success and is achieved in 75%–94% of patients (4). Unlike TURP, there does not



appear to be an upper limit of prostate size that can be effectively treated. Prolonged Foley catheterization is not necessary and is sometimes completely avoided. PAE may be performed as an outpatient procedure with patient discharge typically occurring 4–6 hours after the procedure. Relief begins to occur within days in most cases and side effects are generally mild. Major complications are rare. Complications of urologic surgeries can include blood loss requiring transfusion, bladder incontinence and erectile dysfunction. These have not been reported with PAE. The effect of the treatment is significant with marked reduction in IPSS and improvement in urinary flow rates. These results seem durable over at least 1 year of follow-up. Quality of life scores suggest that patients are quite satisfied with their urinary symptoms following the treatment.

Studies Supporting Prostate Artery Embolization:

The first intentional treatment of BPH with PAE in humans was published in 2010 by Carnevale et al. (5), who demonstrated relief of urinary obstruction and volume reduction in two patients with acute urinary retention. The first randomized controlled trial of PAE versus TURP (6), was recently published by enrolling 114 patients with moderate to severe LUTS and prostate volumes of less than 100 cm^3. At 12-month and 24-month follow-up, both groups showed similar improvements in IPSS, quality of life, peak flow rate, and postvoid residual volume. PAE recipients were less likely to require urethral catheterization and required a shorter hospital stay.

Conclusion:

Prostate artery embolization is a safe, effective, minimally invasive technique to treat lower urinary tract symptoms resulting from benign prostatic hyperplasia. It has the advantage of being an outpatient procedure that requires only local anesthesia and moderate sedation. Patients are discharged the same day with high reported satisfaction scores.

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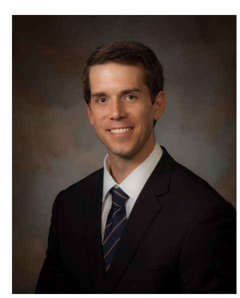


Eye on Safety

By Kenneth Cicuto, MD

I don't know about you, but my wife would say that I could stand to lose some stress, a little attitude, and even a couple of pounds. One thing I don't want to lose is my vision. Can you guess what one of the most radiosensitive tissues in the whole body is? That's right, the lens of your eye. It was long taught that radiation associated cataracts required a dose threshold as high as 8 Sv. Current data would suggest that the actual threshold may only be a fraction of that prior assumption! As the number and complexity of our cases increase, so must our awareness of radiation safety to hold on to one of our favorite senses.

No big deal, right? I have an annual eye exam and my optometrist has never mentioned anything… careful there. Not all cataracts are the same. Cataracts are classified into subtypes by location; nuclear, cortical, and posterior subcapsular. Radiation induced cataracts result in the posterior subcapsular type which can be harder to detect as they are best seen by a nonsubjection Scheimpflug slit-imaging scope or optical coherence tomography, neither which are frequently used. Posterior lens damage decreases contrast sensitivity before visual acuity unlike the more common anterior subtype. Therefore, routine eye chart tests may miss early posterior injury.

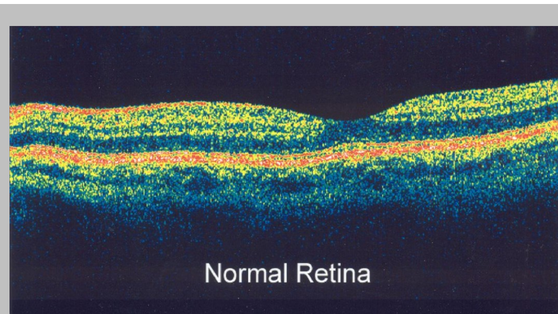
All dose exposure guidelines have been premised on the assumption that everyone at a specific age is equally sensitive to radiation injury but it turns out this was false. Genetics turn out to have a major effect on biological response to radiation damage. Animal and human studies have clearly demonstrated that there is significant variation is the expression of genes associated with radiation repair, so much so that some have proposed that this should be a screening factor for certain professions, such as astronauts exposed to high doses of radiation. In the Occupational Cataracts and Lens Opacity in Interventional Cardiology (O'CLOC) study, after correction for age, sex, smoking, etc., Interventional Cardiologists showed 3 times the rate of posterior lens damage as compared to the control group. Similar data exists for interventional radiologists, nurses and technicians.

This data has changed the recommendations of the International Commission on Radiological Protection (ICRP) on two key components: 1. Ocular threshold is 500mGy (4x lower than previously), 2. Annual dose set at 20mGy with no year exceeding 50mGy. The current limit set by the Nuclear Regulatory Commission (NRC) is 7.5 times higher!

With this in mind, how do we protect these sensitive organs? As a reminder, radiation to the eyes during fluoroscopy is mainly due to scatter from the patient. Modern updated equipment has the ability to drastically lower the radiation of procedures/studies. New equipment please!!!

Let's review some of the basics:

- Lower the frame rate as much as possible to answer the question.
- Collimation: even 1 cm can reduce the scatter by up to 50%.
- Avoid magnification.
- Decrease or avoid angulation. When you must, position yourself on the detector side.
- Move the detector as close as possible to the patient.
- Use last image holds and avoid DSA when you can.
- Get out of the room when you can. If you can't, get your Rn or tech out!



How about barrier protection? Obviously, the best thing would be leaded glasses right? Wrong again. Of course not! Leaded glasses on average reduce eye radiation by a factor of 2.1 on the tube side and 0.8 for the other eye. Glasses that claim the same lead equivalence actually vary in radiation attenuation by 35-95% on bench testing. This is because the degree of attenuation is more dependent on the lens shape and thickness than the Pb value. Appropriate positioning of the lead shield up against the patient is your best bet; studies demonstrating dose reduction by a factor of 5.7 in the left eye and 4.8 in the right eye. Remember, scatter = 1/2 distance, so moving 3 times farther away drops your dose 9 times. Radial access is sounding pretty good now!

Take care of those eyes !!!

Kenneth Cicuto, MD

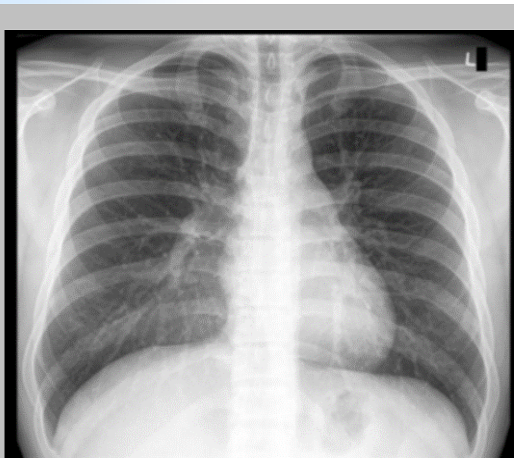
The Good, the Bad, and the Ugly: What Makes a Radiograph "Good" or "Bad"

By Amy Hayes, MD

There are many elements which are important when taking an X-ray and include both technical factors and patient factors.

Patient factors include patient cooperation. For example, is the patient in pain and can they extend their arm at the elbow for an adequate elbow series? Is the patient obtunded or can they follow instructions? Is the patient intubated or can they follow commands and take a deep inspiration for a chest X-ray? Many patient factors are beyond the control of the X-ray tech.

Good positioning. Glenohumeral joint is positioned in the center of the film, in the center of the X-ray beam.



Good positioning. No rotation. Includes lung apices and both costophrenic angles. Excludes extraneous anatomy.

Technical factors include SID, tube angles, kVp ranges, focal spot size and exposure which the technologist will try to keep as uniform as possible so the exam can be replicated. One very important aspect of radiology and the job of the Radiologist, is to compare prior images to the current image. The more variation there is between exams the more difficult it can be to measure and document changes that may have occurred since the prior exam.

When the radiologist opens an exam, they decide almost immediately, whether an exam is "good" or "bad". Most radiologists immediately assess positioning and "exposure" and determine whether the exam is adequate to answer the clinical question.

Positioning

There are many factors which are important in positioning.

1. Is the required anatomy included in the exposure field and is unnecessary anatomy excluded?

2. Is the body part adequately positioned in the exposure field? For example, for a lateral elbow exposure, is it a true lateral? Is the chest rotated on a PA chest X-ray?

3. Is the body part of interest centered in the exposure field?

4. Is the positioning uniform allowing the radiologist to compare with prior films?

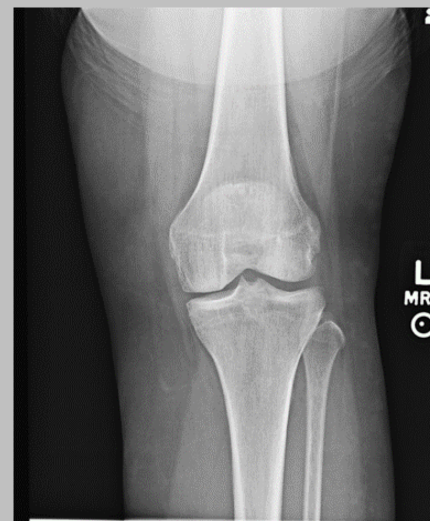
Positioning criteria for all exams should include:

1. Anatomy free of superimposition of other structures.

2. Presentation without rotation or tilt.

3. Appearance of pertinent anatomy without distortion (foreshortening or elongation).

4. Some positions will require presentation of specific anatomy in a particular location or position in reference to another anatomical structure (i.e. lordotic chest should display clavicles superior to lung apices).



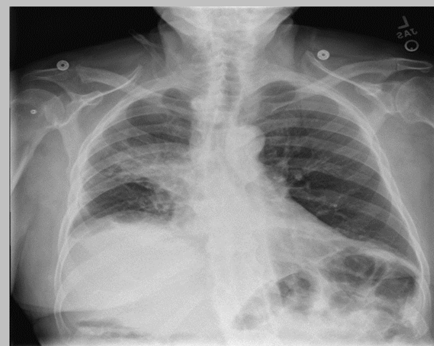
Good positioning. Joint centered in the middle of film.

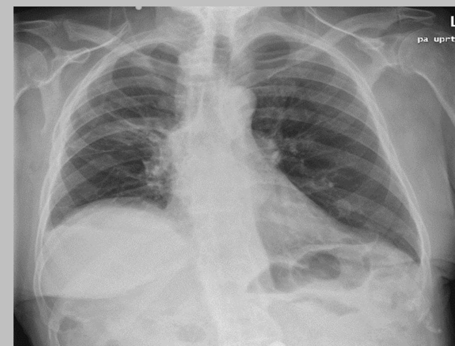
Poor positioning. This is a wrist film and the carpal bones and radiocarpal are not centered, they are positioned at the top of the film. Too much forearm is exposed.

The Good, the Bad, and the Ugly Continued...

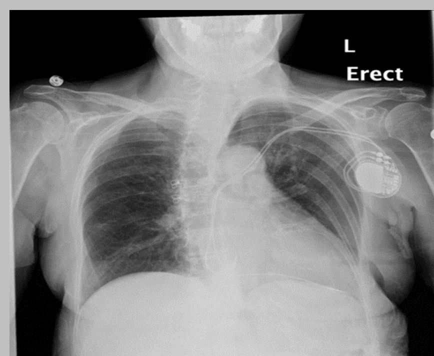
Poor positioning. T spine is shifted left of center.
Too much "dead space" on the right side of the film

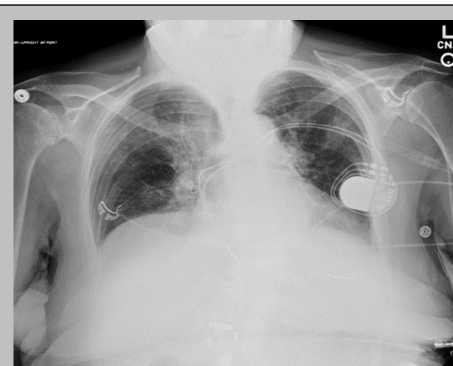
Poor positioning. L1 is not completely included on this L spine film. Includes too much of the coccyx. Film is centered too low.





Good positioning. Similar positioning of the chest (no rotation, similar tube angle) allows the radiologist to more reliably compare the original exam with the follow up study and assess changes.





Very difficult to compare these two images obtained 1 month apart. Left image is rotated to the left and slightly lordotic. Right image is rotated slightly to the right. Poor inspiratory result. Positioning is not uniform.

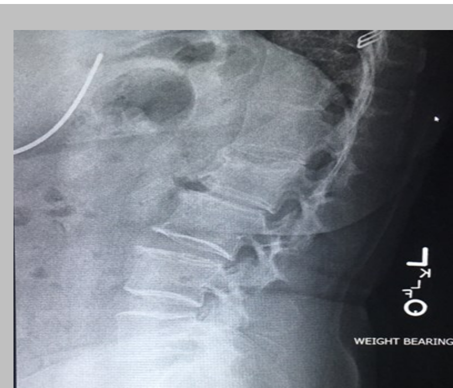


Image on the left was taken to evaluate the L2 compression fracture. Fracture is well profiled, the superior and inferior endplates of L2 are essentially parallel, and the disc spaces above and below L2 are well delineated. Image on the right is a follow-up. L spine is centered too high and the L2 fracture is not in the center of the x-ray beam. The endplates are not superimposed (i.e. do not form a single line) and it is difficult to tell if the vertebral body has become more compressed. Also, the film is slightly under exposed and the contrast and sharpness is not nearly as good as the film on the left.

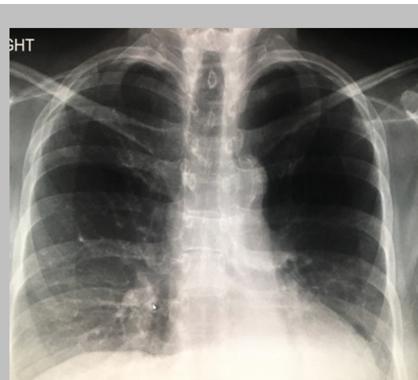
The Good, the Bad, and the Ugly Continued…

Exposure

In addition to positioning, the other parameter that is immediately assessed by the radiologist is "exposure". There are many factors that go into "exposure" but what the radiologist notes is if the film is too light or too dark, under exposed or over exposed, and is there adequate contrast between structures to answer the clinical question or make a diagnosis.

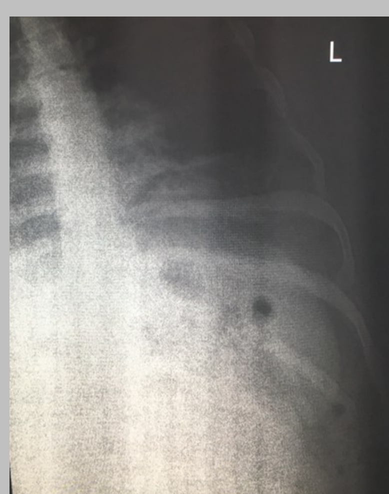
Exposure is uneven. Distal clavicle and acromion are completely burned out and not recoverable even by changing the window and level when viewing on PACS.

When images are underexposed image noise (quantum mottle) will increase and limit the evaluation of fine anatomic detail.



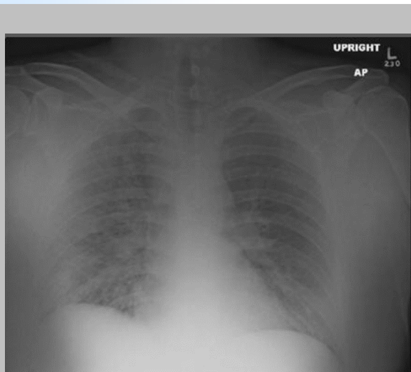
Chest x-ray's are overexposed. The bronchovascular markings in the mid to upper lungs are "burned out". Changing the window or level on the computer screen will not make them visible and that information is lost.

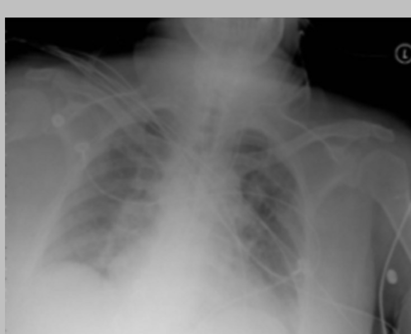
Underexposed films demonstrate significant noise.



The Good, the Bad, and the Ugly Continued…

Image has areas of under exposure and over exposure. Requires manipulation on PACS to adequately read.



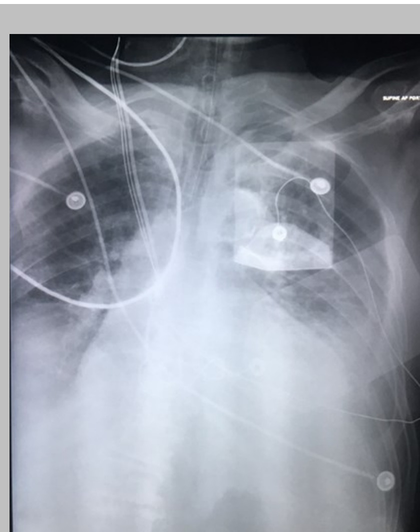


Images are underexposed with very little contrast between lung and soft tissue.

Artifacts

On the film equipment, on the patient, and motion… try to minimize as much as possible.

Obvious artifacts on the patient. This was a pelvis with hip series, looking for a left hip fracture!



Sometimes artifacts are unavoidable but do your best to minimize them.

Amy Hayes, MD

Utility of MR

By Nicholas Statkus, MD

There are many reasons why MR is a useful modality with regards to disease diagnosis. One major benefit of MR is the lack of ionizing radiation. CT and x-ray/radiographs use ionizing radiation to obtain the images. Ionizing radiation can have biological effects which may be unintentionally or intentionally harmful. For example, within the last ten years there has been at least one well publicized incident of unintentional excessive CT dose following CT perfusion for stroke imaging which induced skin/tissue damage on the imaged patients. Radiation oncologists intentionally utilize higher doses, compared to those doses used for diagnostic imaging purposes, of ionizing radiation to damage malignant tissue. MR is a unique diagnostic tool utilizing no ionizing radiation which, in these times of excessive CT usage, is a major plus of this modality.

Another benefit of MR is the ability to visualize and characterize pathology more precisely. MR is able to visualize minute pathology which may not be visible on CT/radiographs. An interesting disease process I would like to use to illustrate this is Wernicke's encephalopathy. Wernicke's encephalopathy is a disease caused by a deficiency of thiamine (vitamin B1) which can manifest clinically with eye movement dysfunction (opthalmoplegia), ataxia, and confusion. The brain is the main area affected by the diminished thiamine. The imaging findings seen with this disease can be seen on MR but will usually not be visible by CT.

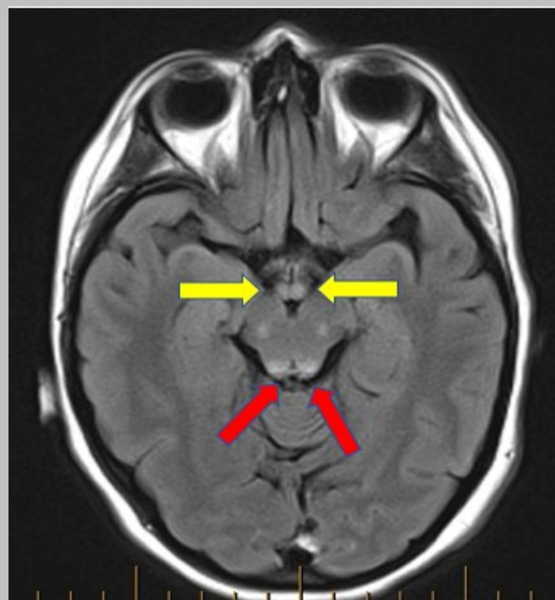


Figure 2: FLAIR image from brain MR in patient with Wernicke's encephalopathy shows abnormal high signal within the tectum (red arrows) and mamillary bodies (yellow arrows).

Figure 1 shows a normal head CT in a patient with Wernicke's encephalopathy.

A pre-and post-contrast MR performed in this same patient shows abnormal high signal within the tectum and mamillary bodies (Figure 2) and abnormal enhancement of the mamillary bodies (Figure 3). This is the typical appearance of Wernicke's encephalopathy on MR. The imaging findings seen with MR are not visible on the CT illustrating the superior ability of MR to diagnose this disease process. Additionally the MR findings are pathognomonic of this disease process and are definitive to diagnose the disease, i.e. there is no other disease process which will show these same findings.

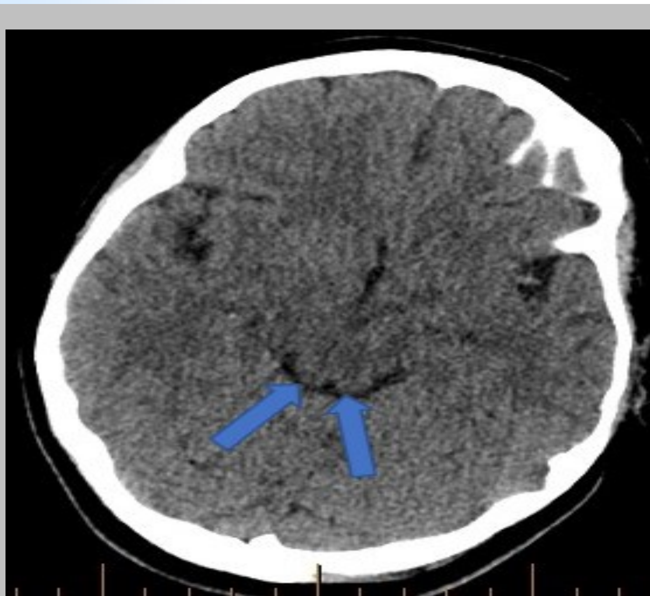


Figure 1: Non-contrast head CT is normal. Arrows indicate the location of the pathology which is visible on MR but not visible by CT.

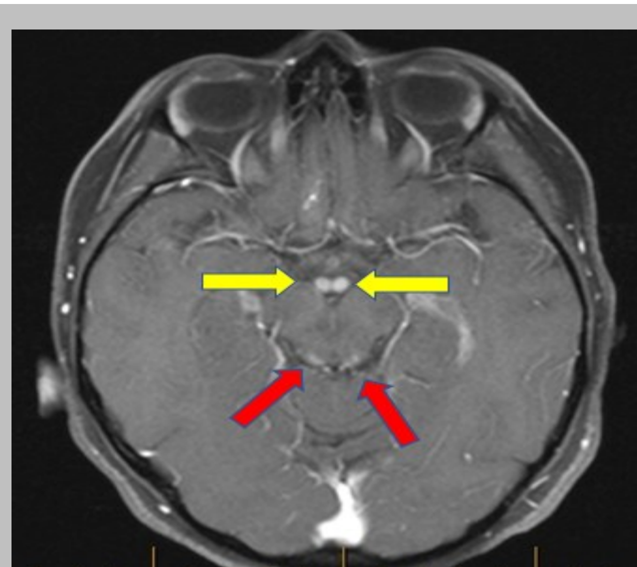


Figure 3: Post-contrast MR shows abnormal tectum (red arrows) and mamillary body (yellow arrows) enhancement correlating with the signal abnormality seen on the FLAIR images (figure 2).

Utility of MR Continued...

MR is also useful to more precisely characterize disease processes which **are** visible on radiographs, CT or both. Additionally, as illustrated with the Wernicke's encephalopathy case, MR may be able determine the exact disease process which is present. The following case illustrates the above. Figures 4 and 5 show a lateral scout image and non-contrast head CT of an incidental bone lesion in the skull of a patient scanned following trauma. There is an expansile lucent lesion in the occipital bone seen on the CT, a non-specific finding which could represent a malignant bony lesion, an inflammatory bony lesion such as eosinophilic granulomatosis, a "brown" tumor in the setting of hyperparathyroidism, or an epidermoid/dermoid tumor.

MR without and with contrast was subsequently performed for further characterization. The MR diffusion images and corresponding ADC map reveal the lesion exhibits diffusion restriction which indicates this lesion either represents a benign epidermoid or dermoid tumor (Figure 6). The MR diffusion sequence essentially seals the deal on the diagnosis of this entity, information which is not obtainable on the CT scan.

These cases are but just a few of many examples which demonstrate the potent diagnostic capability of MR.

Figure 4: Lateral scout image from non-contrast head CT shows a lucent lesion in the occipital bone (red arrow).

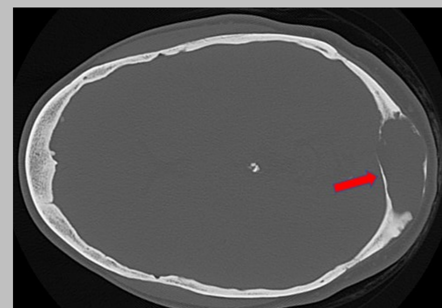


Figure 5: Head CT shows an expansile, lucent lesion in the occipital bone (red arrow).

Nicholas Statkus, MD

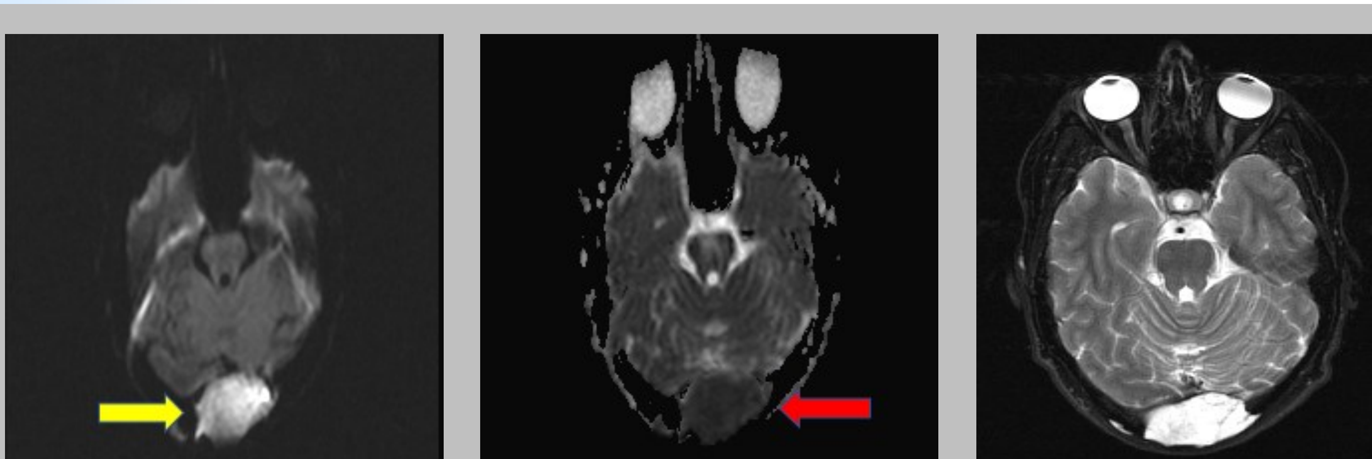


Figure 6: Epidermoid/dermoid tumor of the occipital bone. The left image (diffusion sequence) and middle image (ADC map) show the lesion is bright on diffusion (yellow arrow) and low in signal on the ADC map (red arrow). This indicates there is diffusion restriction in the lesion, a finding which is a defining feature of epidermoid/dermoid tumors within the skull. The right image is an axial T2 image from the MR which shows more detail of the lesion as compared to the diffusion images.

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