

PainWeek

Clinical Pearls: Unraveling the Secrets of Imaging Studies

David M. Glick, DC, DAAPM, CPE

1

Conflict of Interest and Disclosures

- Nothing to Disclose

PainWeek

2

Course Objectives

- Identify basic imaging studies used for the diagnosis of pain disorders.
- Describe the clinical utility and limitations of such studies for the differential diagnosis of pain pathologies.
- Explain strategies to enhance the clinical yield of imaging studies, to reflect clinical relevance.

PainWeek

3

When More Medicine is Less

- Nine United States specialty societies representing 374,000 physicians developed lists of *Five Things Physicians and Patients Should Question*
- [American Academy of Allergy, Asthma & Immunology](#)
- [American Academy of Family Physicians](#)
- [American College of Cardiology](#)
- [American College of Physicians](#)
- [American College of Radiology](#)
- [American Gastroenterological Association](#)
- [American Society of Clinical Oncology](#)
- [American Society of Nephrology](#)
- [American Society of Nuclear Cardiology](#)



http://choosingwisely.org/?page_id=13

4

Choosing Wisely (Initiative of ABIM Foundation):

- Not only are many procedures unnecessary, some are actually harmful and can lead to mistaken diagnosis or endless rounds of follow-up testing when nothing is wrong.
- *“Over testing and over treating is harming people and unethical.”* (Dr. Glen Stream President American Academy of Family Practice Physicians & Panel member)



http://choosingwisely.org/?page_id=13

5

Medical Necessity of Imaging for LBP

- Low back pain is the fifth most common reason for all physician visits.
- Don't do imaging for low back pain within the first six weeks, unless red flags are present.
 - Red flags include, but are not limited to, severe or progressive neurological deficits or when serious underlying conditions such as osteomyelitis are suspected. Imaging of the lower spine before six weeks does not improve outcomes, but does increase costs.



http://choosingwisely.org/?page_id=13

6

MRIs and CT Scans for Headaches

Don't do imaging for uncomplicated headache.

- Imaging headache patients absent specific risk factors (such as loss of vision, seizures, etc) for structural disease is not likely to change management or improve outcome.
- Those patients with a significant likelihood of structural disease requiring immediate attention are detected by clinical screens that have been validated in many settings. Many studies and clinical practice guidelines concur.
- Also, incidental findings lead to additional medical procedures and expense that do not improve patient well-being."



PainWeek https://choosingwisely.org/?page_id=13

7

Choosing Wisely Update

- 72 Societies and 17 community groups have joined the initiative.
- Over 450 recommendations (over 66 lists).
- Hundreds of potentially unnecessary medical tests and treatments have been identified to date.
- Several societies have released 2nd and 3rd lists.
- Estimated 5 billion in potential savings for unnecessary testing.
- >400 Main stream articles/20,000 blogs or Pt stories about unnecessary tests or treatments.

PainWeek

8

Choosing Wisely Update

Figure 5: In your own practice, is this a reason you sometimes end up ordering an unnecessary test or procedure? (N=400)



UNNECESSARY TESTS AND PROCEDURES IN THE HEALTH CARE SYSTEM

Other reasons that affect health care costs, quality, and the bottom line include:

- Overuse of services
- Overdiagnosis
- Over-treatment
- Over-referral/consultation

PainWeek https://www.choosingwisely.org/wp-content/uploads/2014/04/042814_Final-Choosing-Wisely-Survey-Report.pdf

9

Most Important Tools for Differential Diagnosis...

- History
- Clinical Examination
- Experience of Clinician



PainWeek

10

Adverse Factors Affecting Physical Diagnosis

- **Limitations of Time**
 - Volume of patients may limit face-to-face time with clinician.
 - Reimbursements tend to devalue clinical component.
- **Telemedicine**
 - Ability to perform a physician examination can be difficult.
- **Reliance Upon Technology**
 - MRI shows disc herniations so that must be the cause of the patient's neck pain.
- **Clinical Experience**
 - Has the clinician evaluated patients with similar symptoms before

PainWeek

11

**Ordering Advanced Imaging?
Get Ready for New Medicare Rules**

- **January 2020 - Medicare will require that providers use a certified clinical decision support (CDS) system when ordering advanced imaging tests for eight common conditions using so-called appropriate use criteria (AUC).**
- **Purpose - designed to reduce inappropriate use of MRI, nuclear medicine, and CT. The priority conditions covered in the AUC program include:**

• Coronary artery disease	• Shoulder pain
• Suspected pulmonary embolism	• Suspected rotator cuff injury
• Headache	• Suspected or diagnosed lung cancer
• Hip pain	• Cervical or neck pain
• Low back pain	

PainWeek <https://www.cms.gov/medicare/quality-initiatives-patient-assessment-instruments/appropriate-use-criteria-program/index.html>

12

Imaging CDS System

- Documentation will rely on G-codes and modifiers for consultation
- Ordering providers consult CDS, but furnishing providers are responsible for reporting that consultation took place. This claims-based reporting must include three separate items
 - CDSM consulted
 - AUC adherence (Appropriate Use Criteria) applicable or not
 - National provider identification (NPI) number of the ordering professional



13

Does your imaging population health strategy match your level of risk?



- www.advisory.com/pp/2017populationhealth
- https://www.advisory.com/research/imaging-performance-partnership/multimedia/infographics/2017/does-your-imaging-population-health-strategy-match-your-level-of-risk?utm_source=Stuvia.com&utm_medium=PP_IPP_info_x_x_x_RR_2018&utm_campaign=HMKIG#Blog



14

MRI - Magnetic Resonance Imaging

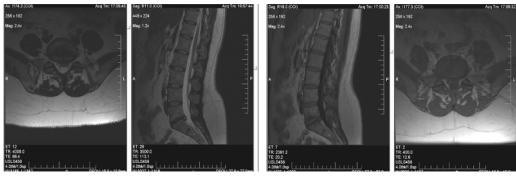


- Uses a **powerful magnetic field** to align the **hydrogen atoms in water** in the body. **Radio frequency (RF) fields are used to energize hydrogen nuclei (protons).**
- **When the field is turned off, energy is released as the protons return to their resting state.** This energy is recorded by the scanner.
- The position of protons in the body can be determined by applying additional magnetic fields (using gradient coils) during the scan, which allows an image of the body to be created.
- Contrast between different types of body tissue is created by changing the parameters on the scanner.
- **Diseased tissue, such as tumors, can be detected because the protons in different tissues return to their equilibrium state at different rates.**



Novelline, Robert. Squire's Fundamentals of Radiology. Harvard University Press. 7th edition, 2018

15



- On a T2-weighted scan, water- and fluid-containing tissues are bright and fat-containing tissues are dark, the reverse is true for T1.
- Damaged tissue tends to develop edema, which makes a T2-weighted sequence sensitive for pathology

PainWeek

16

Clinical Relevance

Interpretation: Degenerative disc disease L5-S1 with moderate left central disc herniation resulting in canal stenosis.

Clinical History: 42 y/o female with onset of low back soon after returning from a trip, without any identifiable underlying cause, starting with morning stiffness, and progressing to constant low back pain w/ intermittent pain and numbness into the left lower extremity.

Treatment Options: **How does the MRI impact treatment options even without considering the examination?**



PainWeek

17

Clinical Treatment Options

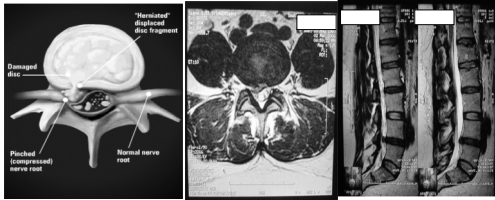
- Exercise & Rest**
Including activity adjustments & stretching
- Oral Medications**
NSAIDs, steroids, muscle relaxants
- Physical Modalities**
PT, spinal manipulation
- Alternative/Complimentary Treatments**
Acupuncture, biofeedback, laser, massage, mindfulness
- Interventional treatments**
Interlaminar vs. transforaminal ESI
- Surgical referral**
Decompression, fusion



PainWeek

18

Nerve Root Compression



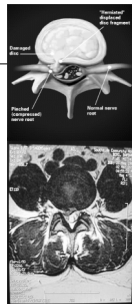
painweek

Image © Swarm Interactive www.swarminteractive.com

19

Clinical Treatment Options

- Exercise & Rest**
Including activity adjustments & stretching
- Oral Medications**
NSAIDs, steroids, muscle relaxants
- Physical Modalities**
PT, spinal manipulation
- Alternative/Complimentary Treatments**
Acupuncture, biofeedback, laser, massage, mindfulness
- Interventional treatments**
Interlaminar vs. transforaminal ESI
- Surgical referral**
Decompression, fusion



Clinical Warning: Prolonged conservative treatment may put the patient at risk of further injury or adversely affecting their response to surgery.

painweek

20

Putting Knowledge to the Test...



Surgical or Non-surgical?
Axial back pain without radicular symptoms

painweek

21

MRI and Correlation with Patient Complaints

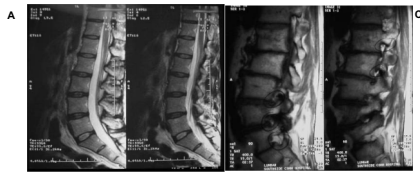


Patient A: Severe debilitating LBP with radiation to left lower extremity, with weakness and sensory loss.
Patient B: Asymptomatic until fall with fracture resulting of the left hip the day of the MRI.



22

MRI and Correlation with Patient Complaints



Patient C: Profoundly abnormal MRI with multiple disc herniations, spondylosis, canal stenosis foramina stenosis, even scoliosis with completely negative examination (physical and EDX) except for gluteus medius trigger point.



23

Clinical Pearl



MRI may demonstrate disc compression of a nerve, but current technology **does not** describe inflammation of a nerve (radiculitis).



While providing valuable structural, they do not necessarily reflect whether a pathology is clinically relevant.

Negative MRI does not rule out an underlying condition.



Image © Swarm Interactive www.swarminteractive.com

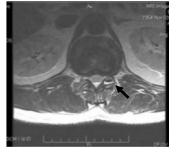
24

Clinical Pearl

Facet joint inflammation

How often does an MRI report identify inflammation of a facet joint?

The individual reading the MRI or other imaging study is often not clinically familiar with the patient



25

What About More Than One Pathology?

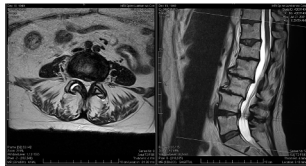
Patient: 71 y/o Female with back and leg pain, demonstrating lower extremity weakness and signs of claudication.

Pathologies evident:
Multiple levels of DJD and spondylosis

Moderate canal stenosis L4-L5

Mild canal stenosis L2-L3

Moderate to severe facet inflammation right L4-L5

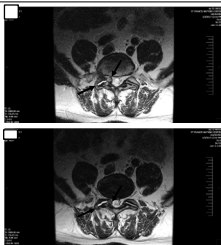


Listen to the patient & consider examination findings:
Intermittent claudication, axial pain and gait issues



26

Controversial Consideration – Radiological Interpretation



Profound L5/S1 facet inflammation

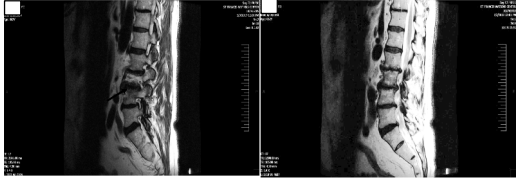


Complex synovial cyst into the IVF and spinal canal



27

Pt with Two Differing Back Complaints

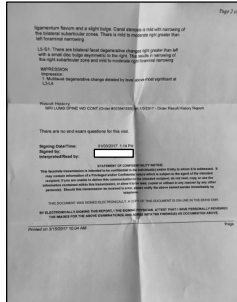
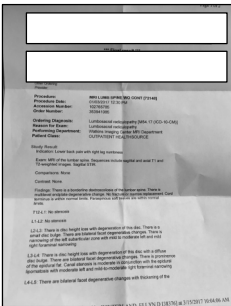


Significant bone marrow edema L3/L4

- Pt Complaints:**
1. Constant axial LBP, cramping in anterior thighs
 2. Intermittent sharp LBP shooting into the right lower extremity.

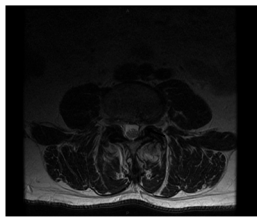


28



29

Epidural Lipomatosis



30

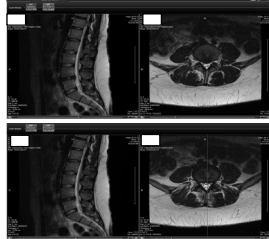
Potential Implications of Overreading Imaging Studies

Pt Complaint: Left sided back and buttock pain w/ radiation into the posterior thigh extending to the knee when most severe.

MRI Observations: Small focal protrusion with disc desiccation without significant canal or foraminal stenosis.

Radiologist Interpretation: Moderate central disc herniation L4-L5 potentially contributing to canal stenosis, no evidence of foraminal stenosis.

Initial treatments: Medications, PT, TF ESI L4-L5, Lumbar MBB, unsuccessful.



31

Post Surgical Imaging

Questions to ask:
Was surgery really necessary?

What did the patient examination show, post surgery (understanding clinical presentation never changed, even after surgery)?

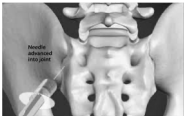
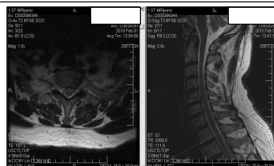
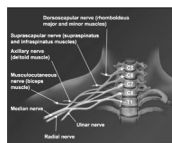


Image © Swam Interactive www.swaminteractive.com

32

Clinical Pearl

Always request axial images to include C8 & T1 roots on order for Cervical MRI



- Brachial Plexus is C5-T1 spinal nerve roots
- All intrinsic muscles of the hand are innervated by C8/T1, as are most muscles for grip
- If upper extremity symptoms extend to hand or include decrease grip strength, then there is a high likelihood C8 or T1 is involved
- Most Cervical MRIs do not image the T1 root, and many do not include C8



Brachial plexus image © Medcom studios – Renee Cannon

33

What does the Literature Say?

MRI of the lumbar spine in people without back pain.

On MRI examination of the lumbar spine, many people without back pain have disc bulges or protrusions but not extrusions. Given the high prevalence of these findings and of back pain, the discovery by MRI of bulges or protrusions in people with low back pain may frequently be coincidental.

... Thirty-six percent of the 98 asymptomatic subjects had normal discs at all levels. With the results of the two readings averaged, 52% of the subjects had a bulge at least one level, 27% had a protrusion, and 1% had an extrusion. 38% had an abnormality of more than one intervertebral disc.



* Jensen MC, Brant-Zawadzki MN, Ouchowski N, Modic MT, et al. Magnetic resonance imaging of the lumbar spine in people without back pain. N Engl J Med. 1994 Jul 14;331(2):69-73. (PMID: 8208267)

34

The Use of Lumbar Spine Magnetic Resonance Imaging in Eastern China: Appropriateness and Related Factors.

We retrospectively studied 3107 lumbar spine MRIs in Eastern China to investigate the appropriateness of lumbar spine MR use (From January 1st to January 31st of 2013 - 1369 male and 1738 female patients, age 52.73±16.14 years, range 3 to 100 years) underwent lumbar MR imaging at the included 10 hospitals

Only 41.7% of all lumbar spine MR studies were considered as potentially clinically positive diagnosis. Findings of the remaining 58.3% lumbar spine MRIs were regarded as clinically negative. Normal lumbar spine is the most common diagnosis (32.7%) on lumbar spine MRIs, followed by lumbar disc bulging (26.2%) and lumbar disc herniation (15.0%)



<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0146899>
Liedao Yu, Xuanwei Wang, Xiangjin Lin, Yue Wang, Pub Jan 2016

35

MRI of the lumbar spine in people without back pain.

- 148 asymptomatic subjects - 69 (46%) had never experienced low back pain
- 123 subjects (83%) with moderate to severe desiccation of one or more discs
- 83 (56%) with loss of disc height
- 48 subjects (32%) had at least one disc protrusion
- 9 (6%) had one or more disc extrusions. 1

Armed with an interesting application of the Jarvik data, when including the epidemiological information with the MR imaging reports McCullough's group cited a slightly lowered incidence of opioid prescriptions, physical therapy and repeat injections. 2 Clearly utilization may have been affected, there was however no information concerning treatment outcomes.



1. Jarvik JJ, Hollingworth W, Heagerty P, Haynor DR, Deyo RA. The Longitudinal Assessment of Imaging and Disability of the Back (LAIIDBack) Study: baseline data. Spine (Phila Pa 1976) 2001;26(10):1158-1166.
 2. McCullough BJ, Johnson GR, Martin BI, Jarvik JG. Lumbar MR imaging and reporting epidemiology: do epidemiologic data in reports affect clinical management? Radiology. 2012;262(3):941-6.

36

The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects

MRIs were not predictive of the development or duration of low-back pain. Individuals with the longest duration of low-back pain did not have the greatest degree of anatomical abnormality on prior scans. Clinical correlation is essential to determine the importance of abnormalities on magnetic resonance images.

.... 77 asymptomatic individuals with no history of back pain underwent magnetic resonance imaging of the lumbar spine. 21 subjects (31%) had an identifiable abnormality of a disc or of the spinal canal. In the current study, we investigated whether the findings on the scans of the lumbar spine that had been made in 1989 predicted the development of low-back pain in these asymptomatic subjects.



Borenstein DG, O'Mara JW Jr, Boden SD, Lauerman WC, et al. The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects: a seven-year follow-up study. J Bone Joint Surg Am. 2001 Sep;83-A(9):1306-11. PMID: 11568190

37

MRI of cervical intervertebral discs in asymptomatic subjects

- 497 asymptomatic subjects evaluated by cervical MRI
- Frequency of all degenerative findings increased linearly with age
- Disc degeneration was the most common observation
 - 17% males / 12% females in their twenties
 - **86% male / 89% females over 60 years of age**
- Significant differences in frequency between genders for posterior disc protrusion and foraminal stenosis
- 7.6% of subjects over 50 were identified as having cord compression



MRI of cervical intervertebral discs in asymptomatic subjects. Matsumoto M¹, Fujimura Y, Suzuki N, Nishi Y, Nakamura M, Yabe Y, Shiga H, J Bone Joint Surg Br. 1998 Jan;80(1):19-24.

38

Miscellaneous Consideration

"Among workers with LBP, early MRI is not associated with better health outcomes and is associated with increased likelihood of disability and its duration."



As soon as patients are told they have a disc herniation they often feel permanently harmed by their job or employer, even when it is found not to contribute to their problem.



Graves, Janessa M, Fulton-Kehoe, Deborah, Jarvik, Jeffrey G, Franklin, et. al., Early Imaging for Acute Low Back Pain: One-Year Health and Disability Outcomes Among Washington State Workers, Spine. 37(18):1617-1627, August 15, 2012.

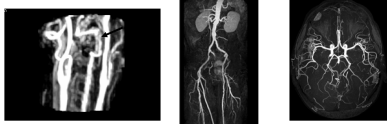
39

MRA - Magnetic Resonance Angiography

generate pictures of the arteries in order to evaluate them for stenosis or aneurysms with the use of contrast or flow-related enhancement.

MRA is often used to evaluate the arteries of the neck and brain, the thoracic and abdominal aorta, the renal arteries, and the legs.

Interpretation failed to identify clearly evident pathology even with Vertebral Artery Insufficiency clearly reflected in the order for the study.

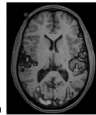


PainWeek

40

fMR ...Not yet ready for prime time.

To see how well fMRI could do at measuring pain, the authors evaluated an fMRI-based measure of pain intensity across four studies with 114 total healthy participants.



The authors felt that it may be possible to assess and differentiate pain through an fMRI scan

Wager TD, et al. "An fMRI-based neurologic signature of physical pain." *N Engl J Med* 2013; 368(15): 1388-1397. DOI: 10.1056/NEJMoa1204471.

PainWeek

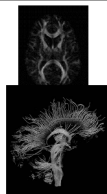
41

Diffusor Tensor Imaging dMRI

Maps diffusion process of molecules (water) in biological tissues.

Provides the ability to visualize anatomical connections between different parts of the brain.

Combined with fMRI (DfMRI) may be able to generate images of neuronal activation of the brain.



Haomann et al. "Understanding Diffusion MR Imaging Techniques: From Scalar Diffusion-weighted Imaging to Diffusion Tensor Imaging and Beyond." *RadioGraphics*. Oct 2006.

PainWeek

42

CT - Computed Tomography

- Earlier referred to as CAT (computed axial tomography) scan, employs tomography. Digital geometry processing is used to generate a 3D image of the inside of an object from a large series of 2D x-rays images taken around a single axis of rotation.
- Has become the gold standard for diagnosis of a large number of different diseases or pathologies.



43

CT - Advantages over traditional radiography

- CT completely eliminates the superimposition of images of structures outside the area of interest.
- Since CT inherently demonstrates high-contrast resolution, differences between tissues that differ in physical density by less than 1% can be distinguished.
- Data from a single CT imaging procedure can be viewed as images in the axial, coronal, or sagittal planes.



44

Traditional CT of the Lumbar Spine



45

CT with 3D Reconstruction

Radiologist Interpretation: Multiple levels of DJD evident from T12-S1, with profound spondylosis L5-S1.

Clinically Relevant Interpretation: Normal age associated degenerative disc disease, without evidence of canal or foraminal stenosis.

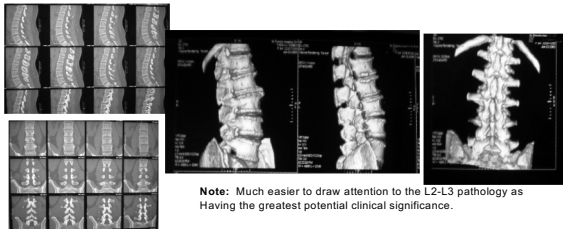
Clinical Examination: Sacroiliitis

Ultimate treatment (successful): Intra-articular SI injection and SI manipulation.



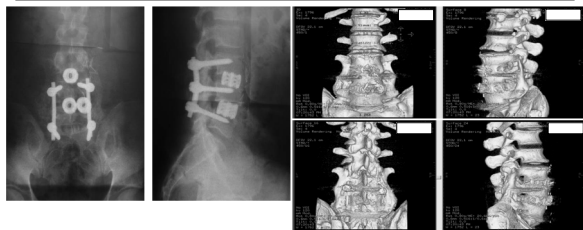
46

Traditional CT vs. Addition of 3D Rendering



47

X-ray vs. CT



48

Profound Clinical Observations

- Severe excess diffuse hyperostosis
- L4-L5: Stenosis with moderate bony compression of the bilateral L4 nerve roots
- L5-S1: Stenosis with severe bony compression of the bilateral L5 nerve roots

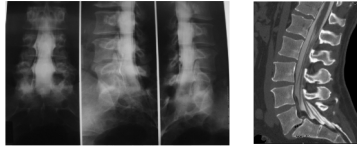


49

CT Myelogram

Speaker Observation: We often see patients a positive myelogram, without clinical significance or electrodiagnostic evidence of a myelopathy.

- Address a limitation of CT to assess neural structures in the spine by combining with Myelography (injecting radiographic contrast into the spinal canal (CSF) to help illuminate the spinal canal, cord, and nerve roots during imaging, particularly sensitive at detecting small herniations resulting in root compression).
- Often ordered by surgeons for operative planning or as a substitute for MRI imaging for patients who cannot have an MRI.



50

Bone Scan

- A nuclear scanning test that can identify areas of new bone growth or destruction. It can be done to evaluate damage to the bones, find cancer that has spread (metastasized) to the bones, and monitor conditions that can affect the bones (including infection and trauma).
- A bone scan can often find a pathology days to months earlier than a regular X-ray test.



Fischbach FT, Dunning MB III, eds. *Manual of Laboratory and Diagnostic Tests*, 10th ed. Philadelphia: Lippincott Williams and Wilkins, 2018.

51

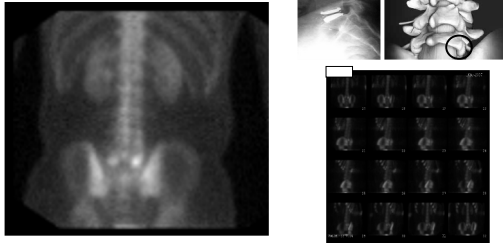
Bone Scan

- Radioactive tracer is injected into the patient. After 2-5 hours, a gamma camera is then used to image the body.
- Abnormalities are identified by "hot spots" and "cold spots."
 - Hot - accumulation of tracer caused by a fracture that is healing, bone cancer, a bone infection or a disease of abnormal bone metabolism.
 - Cold - certain type of cancer (such as multiple myeloma) or bone infarction.

PainWeek Fischbach FT, Dunning MB III, eds. *Manual of Laboratory and Diagnostic Tests*, 10th ed. Philadelphia: Lippincott Williams and Wilkins, 2018.

52

Lumbar Facet Inflammation Status Post L5-S1 Artificial Disc Replacement

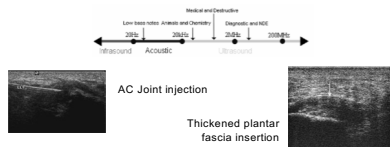


PainWeek

53

Ultrasound

- **Ultrasound** is cyclic sound pressure with a frequency greater than the upper limit of human hearing
- Can capture size and structure of anatomical structures or pathological lesions in real time



PainWeek

54

Handheld Technology

- Handheld Diagnostic Ultrasound
 - black and white anatomic and color-coded blood flow images in real-time
 - heart, abdominal organs, urinary bladder and will provide insights in areas of Ob/Gyn, pleural fluid, motion detection and pediatrics
 - Musculoskeletal applications, tears, inflammation etc.



55

Take Home Message

- The reliability or the clinical relevance of any diagnostic procedure is never 100%.
- The studies themselves may be deficient in that particular clinical situation.
 - Inadequately structured for that particular patient.
 - Adversely effected by other influences (technical considerations).
- Imaging studies can be overread, underread or misread, in the very least require clinical correlation.
- Objective clinical examination findings should not be dismissed based solely upon negative test results.



56

Thank you!



dg@painrx.net



57
