

TWO CASES: CHIROPRACTIC IMAGING

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SURPRISES IN IMAGING

- Cases to be presented remind us that we need to “do our own work”.
- Good history and examination should elucidate much information and allow us to arrive at a diagnosis prior to treatment or referral.
- However, there are situations that imaging will disclose findings that change our impression and final diagnosis.
- Decisions to obtain imaging should be based on our history and exam findings. (not just by “guidelines” or third party payor mandates)

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CASE 1: 8 YOA FEMALE

- Lower back pain. 8 -9 months duration.
- Cannot run, constant pain,
- Prior blue ribbon gymnast. Now not able to perform gymnastics.
- Receiving monthly OMT –osteopathic manipulation for tx.
- No imaging.

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8 YOA FEMALE

- Patient's mother reports that she had been seen at a Large hospital in KC. DX with Sjogren's and "hypermobility syndrome" No spinal x-rays or imaging. Mother says someone did hip and knee plain films.
- Pt. cannot run due to pain in back. Visible gait change with splinting or protecting of the back with trying to run, gets to a faster walk and appears as though she has adductor muscle hypertonicity pulling knees together. (almost like spastic gait). Mother says before pain started this kid was an athletic gymnast.

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8 YOA FEMALE

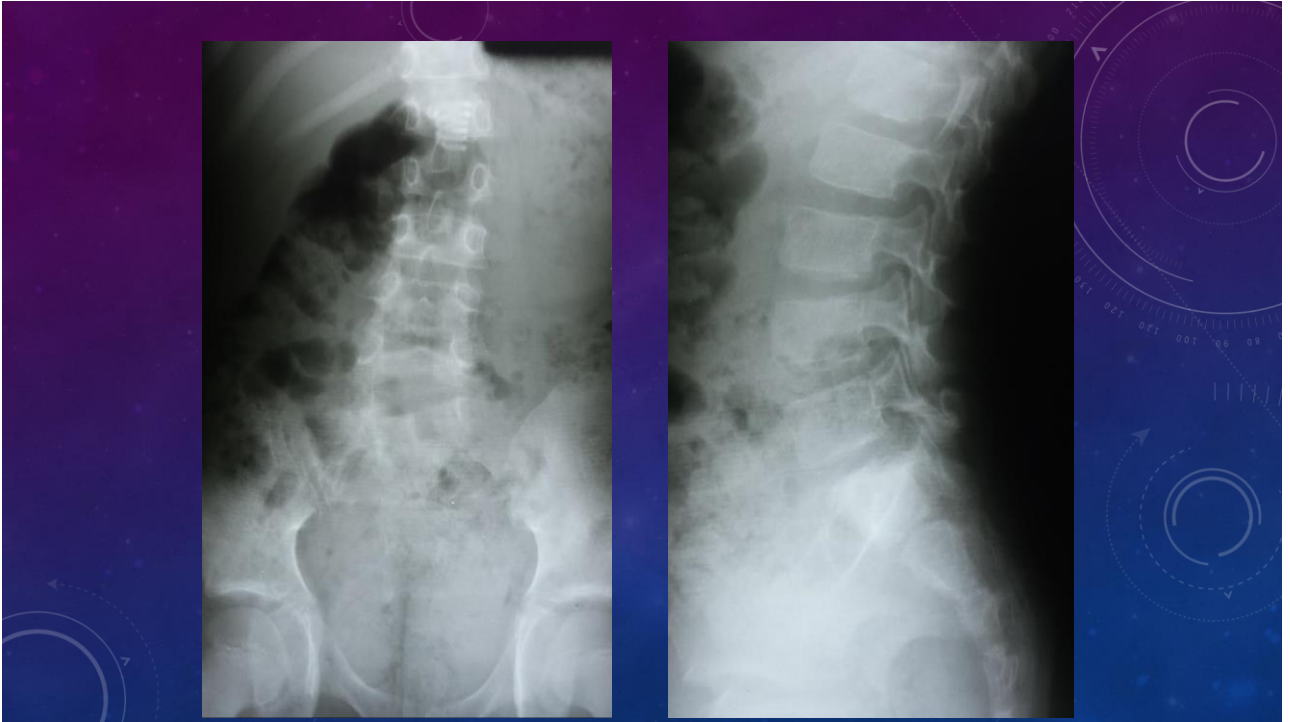
- Exam: reduced and painful ROM lumbar spine in all movements.
- + hop test.
- Crying pain to palpation at L/S junction.
- Cannot perform fast walking without limping gait.
- DTR's +2/4, Myostrength- legs +5/5, No sensory losses.

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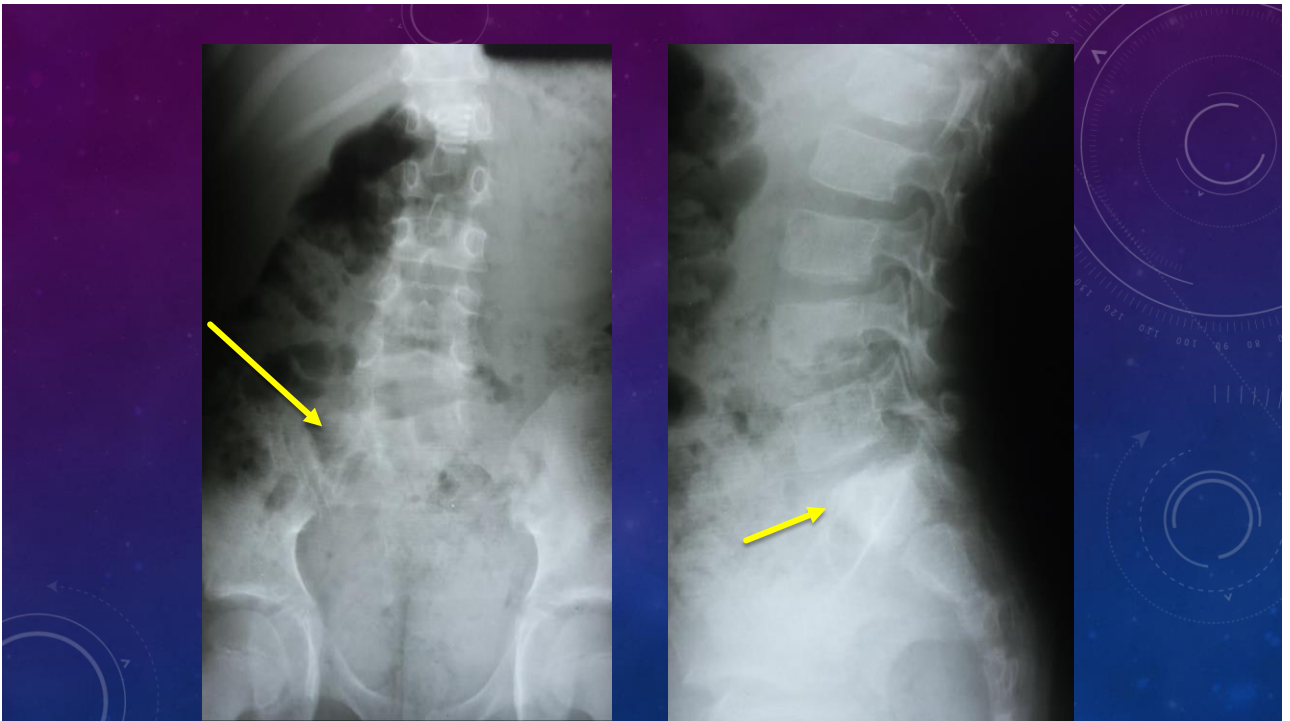
8 YOA FEMALE

- Due to patient's continued pain and range of motion deficits and walking difficulties.
- Lumbar spine radiographs were obtained.
- Patient's physical presentation is similar that seen in slightly older children with active spondylolysis or posterior arch stress reaction.

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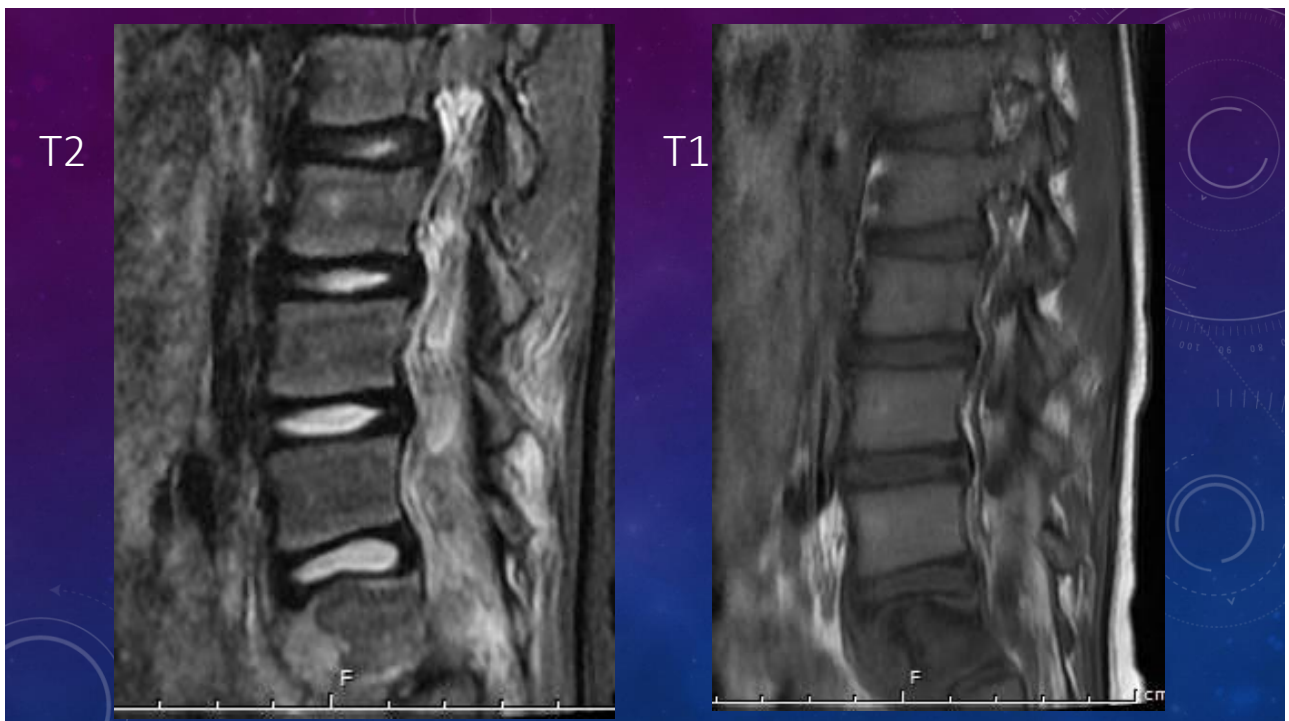


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8 YOA FEMALE

- Lumbar spine radiographs revealed increased density of the S1 segment.
- Possible radiolucent region at the superior portion of the right sacral ala. Bowel gas and content patterns over the region reduce visibility.
- MRI of the lumbar spine was ordered for further evaluation of the lower back. Rule out spondylolysis or posterior arch stress reaction and for further evaluation of S1.

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DIFFERENTIAL DIAGNOSIS

- Clinical differential diagnosis:
 - Strain of lumbar spine.
 - Active posterior arch stress reaction or spondylolysis.
 - Osseous pathology due to appearance of radiographs – sacrum.

Imaging Differential Diagnosis:

Chordoma
Chondrosarcoma
Ewing's Sarcoma
Osteosarcoma
Fibrous dysplasia

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DIFFERENTIAL CONSIDERATIONS

- Spondylolysis – spondylolisthesis in the Adolescent athlete
- Our young lady is younger than the usual Adolescent athlete that I have seen in the office and DX with stress response.
- In my opinion: Posterior arch stress fractures are an “epidemic” in the sports population. The school districts that I cover have this injury occur each year. 3 years ago I had 3 football payers at one school and another volleyball player at the other school in back braces and resting from sport, due to active spondylolysis.

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Case example of stress injury



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CASE REPORT**Stress fracture of the thoracic spine in an elite rhythmic gymnast : A case report**Subash C Jha¹, Toshinori Sakai¹, Mika Hangai², Akiko Toyota¹, Shoji Fukuta¹, Akihiro Nagamachi¹, and Koichi Sairoy¹¹Department of Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School, Tokushima, Japan, ²Department of Orthopedics, Medical Center Japan Institute for Sports Sciences, Tokyo, Japan

Abstract : Spondylolysis, a defect or stress fracture of the vertebral pars interarticularis, occurs most frequently in the lower lumbar spine and occasionally in the cervical spine, but is extremely rare in the thoracic spine. We report the case of a 17 year -old girl, an elite rhythmic gymnast, who reported with early -stage thoracic spondylolysis at T10 and T11 levels. Physicians should be aware that performance of unusual athletic movements, such as those by gymnasts, may lead to spondylolysis in rare locations. *J. Med. Invest.* 63 : 119- 121, February, 2016

Keywords : Stress fracture, Thoracic spine, Spondylolysis, Athletes

INTRODUCTION

Low back pain (LBP) is common in young competitive athletes and is a frequent reason for lost training and playing time. Chronic severe LBP in adolescent athletes may be caused by spondylolysis (1, 2), a defect or stress fracture of the vertebral pars interarticularis most commonly occurring in the lumbar spine, particularly at L5 (3). Spondylolysis is also found, although less often, in the cervical spine (4, 5) but rarely if ever in the thoracic spine, as we are aware of no published reports of thoracic spondylolysis. Here, we

deformity at T10 (Fig. 1). Parasagittal short tau inversion recovery (STIR) images showed high signal changes indicative of bone marrow lesion around the articular processes of T10 and T11 vertebrae (Fig. 2). On axial STIR images, bone marrow edema was more evident on the right side of T10 and T11 laminae (Fig. 3). Computed tomography (CT) scans showed a fracture line at the right inferior articular process of the T10 vertebrae (Fig. 4). The final diagnosis was stress fracture of the right inferior process (early-stage spondylolysis) of the T10 vertebrae and stress reaction of the pars interarticularis (very early-stage spondylolysis) of

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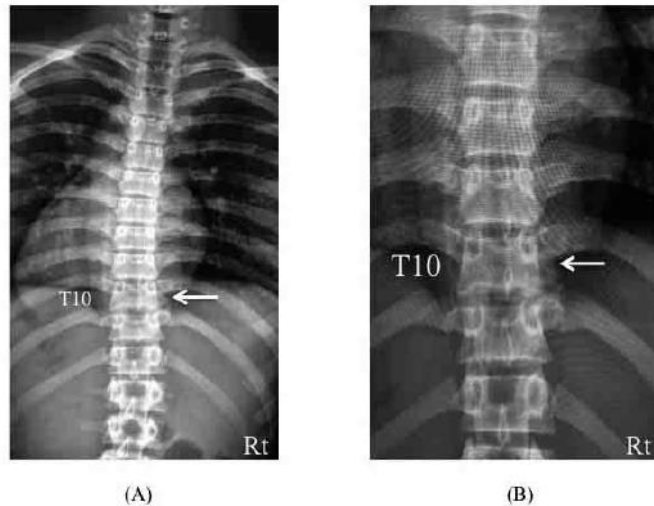


Figure 1.
Plain radiographs of the thoracolumbar spine showing no obvious abnormality except mild scoliosis with slight left rotational deformity at T10 (arrow).

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S. C. Jha, et al. Stress fracture of the thoracic spine

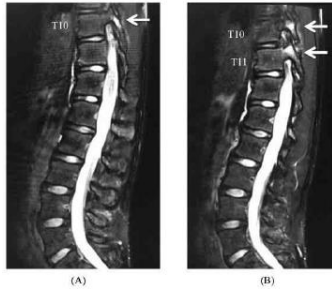


Figure 2. Para-sagittal STIR-MRI showing high signal changes (arrows) indicating bone marrow lesion around the articular processes of T10 and T11 vertebrae.

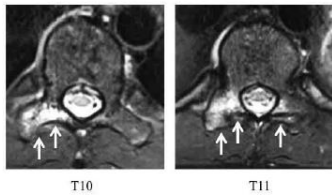


Figure 3. Axial STIR image showing more severe bone marrow edema on the right side of T10 and T11 laminae.

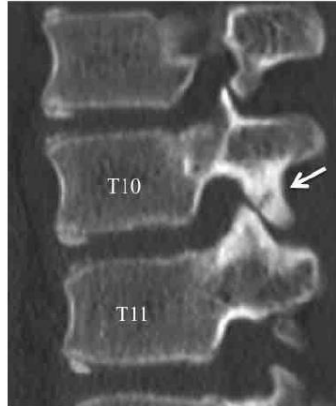


Figure 4. Right parasagittal multi-planar reconstruction CT images showing a fracture line at the right inferior articular process of the T10 vertebrae.

both extension and rotation (8).

The pathogenesis of the present case is still unclear. A kinematic study of a contortionist in an open-configuration magnetic resonance scanner (9) found no evidence for abnormal segmental motion, physiologic limits, segmental motion, or subluxation, even in extreme body contortions. Accordingly, we speculate that her slight left rotational deformity at T10 combined with specific trunk movements required for rhythmic gymnastics may have led to the defect

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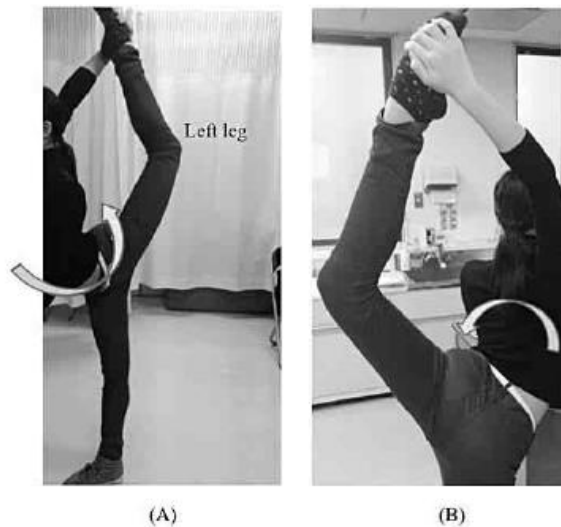


Figure 5. Pictures showing a specific movement required for rhythmic gymnastics. The patient's trunk is hyperextended (A) and rotated to the left side toward the pelvis (B).

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IMAGING OF SACRAL LESIONS:

- No Good Comes Of A Sacral Mass
- No: Neurogenic tumors, Benign neurofibromas, schwannomas, Malignant peripheral nerve sheath tumor
- Good: Giant cell tumor
- Comes: Chordoma, Benign notochord cell tumor (BNCT)
- Of: Osteblastoma
- A: Aneurysmal bone cyst (ABC)
- Sacral: Sarcomas, Ewing's sarcoma, Osteosarcoma, Chondrosarcoma,
- "Simulators" : Red marrow, Paget disease, Stress fractures
- Mass: Mets, myeloma, lymphoma, Meningocele and Tarlov cysts

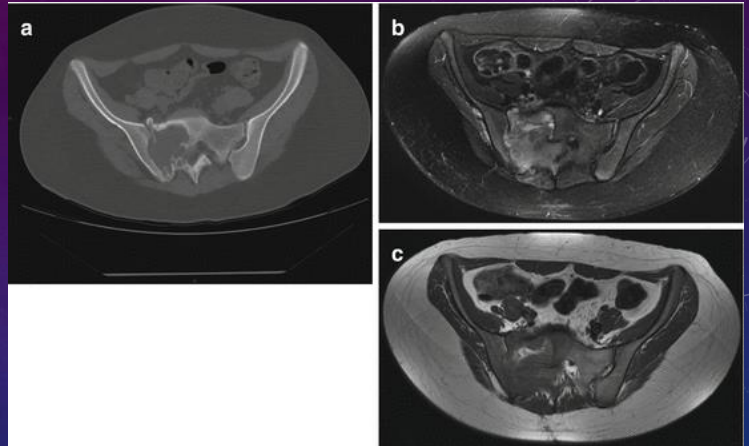
<https://radiologykey.com/imaging-of-sacral-tumors-and-tumor-simulators-experience-of-the-mayo-clinic/>

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Age in years	Less than 20	20–40	Greater than 40
Benign	ABC	Giant cell tumor Schwannoma	Tarlov cysts Tumor simulators Stress fracture Paget disease Red marrow
	Osteoblastoma	Neurofibroma	MPNST, usually <50 Chordoma Mets Myeloma
Malignant	Ewing's sarcoma	MPNST	Lymphoma Chondrosarcoma Osteosarcoma (secondary to radiation and Paget disease)
	Osteosarcoma	Osteosarcoma	

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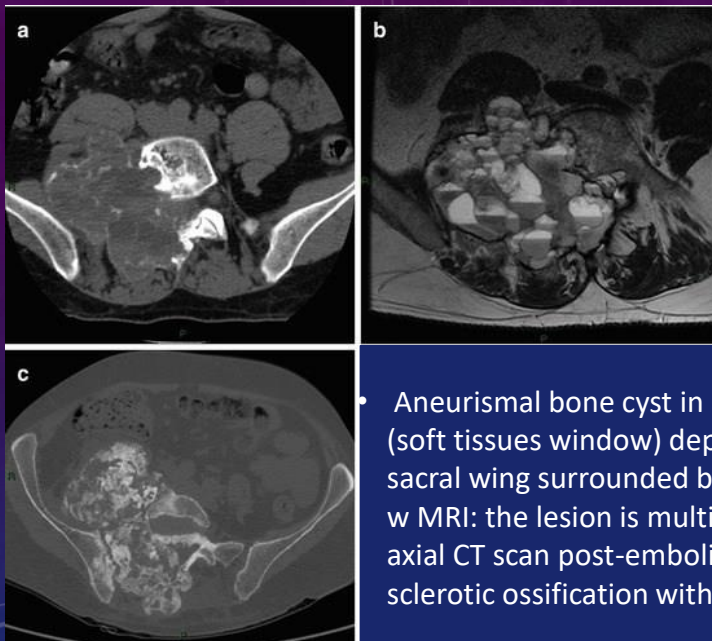
EWIING'S SARCOMA



- Ewing sarcoma in a 20-year-old woman: (a) axial CT, (b) axial T2-w Fat Sat MRI image, (c) axial T1-w MRI image.
- The lesion appears as a destructive osteolysis with a sclerotic reaction and invasion of right sacral foramina and sacro-iliac joint

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ANEURISMAL BONE CYST

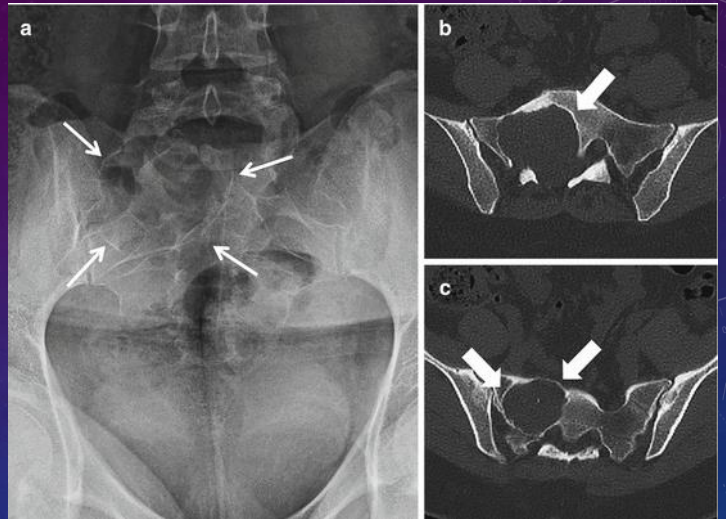


- Aneurismal bone cyst in an 18-year-old boy. (a) Axial CT scan (soft tissues window) depicts an osteolytic lesion in the right sacral wing surrounded by a thin sclerotic border. (b) Axial T2-w MRI: the lesion is multiloculated with fluid–fluid levels, (c) axial CT scan post-embolization (bone window) shows a sclerotic ossification within the cyst

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SCHWANNOMA

- 33-year-old female with a schwannoma demonstrate a lytic expansile lesion centered upon the right S1 neural foramen. Although the lesion is detected on the radiograph (thin arrows), it could easily be confused with overlying bowel gas.
- The CT shows the lesion to better advantage and characterizes the benign nature of the growth pattern with expansion of the bone and a thin peripheral rim of sclerosis (thick arrows)

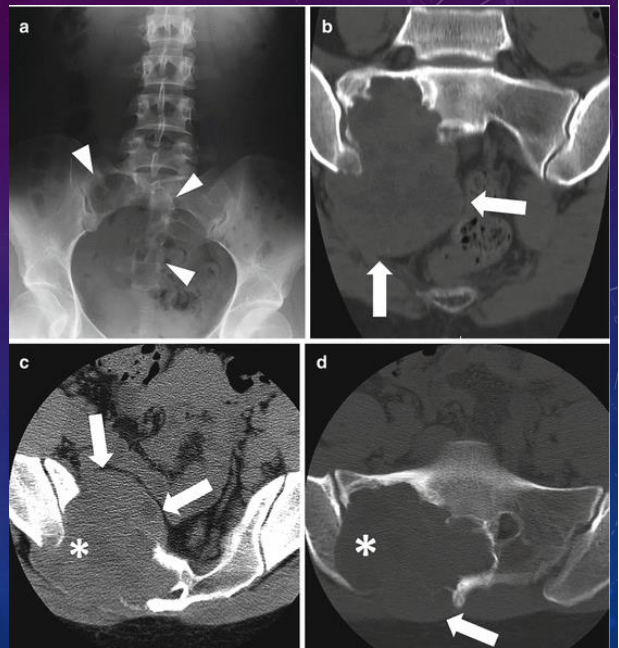


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GIANT CELL TUMOR

- Giant cell tumor of the sacrum in a 29-year-old female. The lesion demonstrates a purely lytic pattern of destruction with a peripheral rim of sclerosis and a large associated soft tissue mass anteriorly and posteriorly (arrows). The lesion also crosses the SI joint (asterisk) and involves the adjacent ilium.



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CHORDOMA

61-year-old male show typical imaging features of a chordoma with a lytic destructive lesion in the lower sacrum that is centered on the midline, has a large associated exophytic presacral soft tissue mass.

MR images show a large heterogeneous solid destructive mass involving the majority of the sacrum and coccyx typical of chordoma.

The MRI nicely demonstrates both the intraosseous and extra-osseous extent of the tumor. There are areas of increased signal within the mass on T1 indicative of intralesional hemorrhage (asterisk), and the mass shows minimal patchy enhancement that reflects the myxoid component of the tumor.

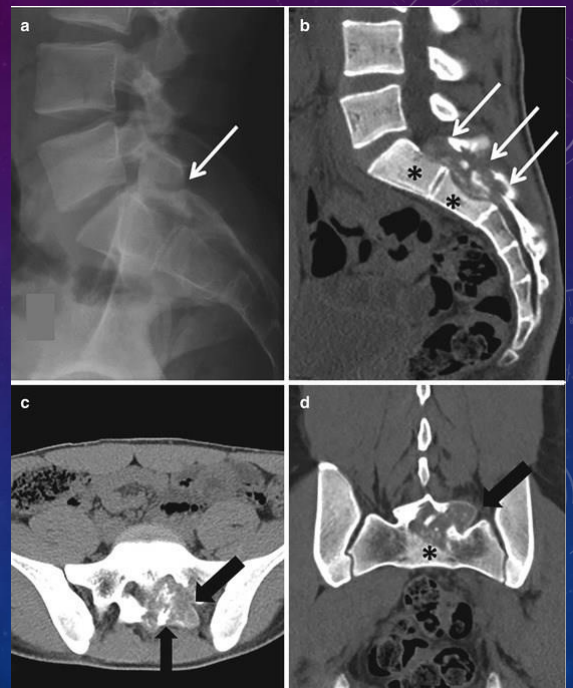
<https://radiologykey.com/imaging-of-sacral-tumors-and-tumor-simulators-experience-of-the-mayo-clinic/>



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- 17-year-old male with an osteoblastoma show a solid mass with internal calcifications involving the posterior elements of S1 and S2 (thin arrows) that is associated with expansion of the bone (thick black arrows) as well as surrounding medullary sclerosis (asterisks)

<https://radiologykey.com/imaging-of-sacral-tumors-and-tumor-simulators-experience-of-the-mayo-clinic/>



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8 YOA FEMALE

- Dx: biopsy of L/S region was inconclusive
- Bone scan showed uptake in patella. Biopsy of patella reveals. Langerhans Cell Histiocytosis.

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LANGERHANS CELL HISTIOCYTOSIS (EOSINOPHILIC GRANULOMA)

- Langerhans cell histiocytosis (LCH) is a lesion belonging to a group of disorders now classified by the World Health Organization (WHO) as histiocytic and dendritic cell disorders (39).
- The incidence in the United States is estimated at 0.05 to 0.5 per 100,000 children per year, with a 2:1 male predominance (20,45,49).
- This disorder represents less than 1% of all biopsy-proven primary bone lesions
- Histiocyte = tissue macrophage, or a Dendritic cell. Dendritic cells are found in tissue that has contact with the outside environment such as the over the skin (present as Langerhans cells) and in the linings of the nose, lungs, stomach and intestines. Immature forms are also found in the blood.

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LANGERHANS CELL HISTIOCYTOSIS;

- Langerhans cell histiocytosis is a disorder in which excess immune system cells called Langerhans cells build up in the body.
- Langerhans cells, which help regulate the immune system, are normally found throughout the body, especially in the skin, lymph nodes, spleen, lungs, liver, and bone marrow.
- In Langerhans cell histiocytosis, excess immature Langerhans cells usually form tumors called granulomas.
- Many researchers now consider Langerhans cell histiocytosis to be a form of cancer, but this classification remains controversial.

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LANGERHANS CELL HISTIOCYTOSIS;

- In approximately 80 percent of affected individuals, one or more granulomas develop in the bones, causing pain and swelling. The granulomas, which usually occur in the skull or the long bones of the arms or legs, may cause the bone to fracture.
- Other signs and symptoms that may occur in Langerhans cell histiocytosis, depending on which organs and tissues have Langerhans cell deposits, include swollen lymph nodes, abdominal pain, yellowing of the skin and whites of the eyes (jaundice), delayed puberty, protruding eyes, dizziness, irritability, and seizures.
- About 1 in 50 affected individuals experience deterioration of neurological function (neurodegeneration).

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LANGERHANS CELL HISTIOCYTOSIS;

- Langerhans cell histiocytosis is often diagnosed in childhood, usually between ages 2 and 3, but can appear at any age. Most individuals with adult-onset Langerhans cell histiocytosis are current or past smokers; in about two-thirds of adult-onset cases the disorder affects only the lungs.
- The severity of Langerhans cell histiocytosis, and its signs and symptoms, vary widely among affected individuals. Certain presentations or forms of the disorder were formerly considered to be separate diseases.

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LANGERHANS CELL HISTIOCYTOSIS (LCH);

- Older names that were sometimes used for forms of Langerhans cell histiocytosis include;
- Eosinophilic granuloma,
 - EG is the most common expression of LCH and is a benign, solitary lesion of bone.
 - It can affect any bone, and is more common in the skull, mandible, spine, ribs, and long bones.
 - In long bones such as the femur, humerus and clavicle, EG often presents as a modestly destructive lytic lesion with a characteristic “punched out” appearance. (Herring, 2014)

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LANGERHANS CELL HISTIOCYTOSIS (LCH);

- EG – spine:
- Vertebra Plana
- In the spine, immobilization with a brace has been shown to be sufficient to allow remodeling and reconstitution of vertebral height (Plasschaert, 2002)



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HAND-SCHÜLLER-CHRISTIAN DISEASE

- Hand-Schüller-Christian disease, a form of LCH
- (multisystem disease without risk organ involvement)
- This syndrome (15 to 40% of LCH cases) occurs in children aged 2 to 5 years and in some older children and adults.
- A disease in which histiocytes start to multiply and attack the tissues or organs of the patient.
- The most frequent sites of bony involvement are the flat bones of the skull, ribs, pelvis, and scapula (wing bone).
- Chronic otitis media due to involvement of the mastoid and the temporal bone is common. Diabetes insipidus affects some patients, mainly children who have systemic disease.
- Up to 40% of children with it have short stature.



No Pain, No fever. Beveled appearance "hole within a hole"

Case courtesy of Dr Subash Thapa, Radiopaedia.org

From the case

rID: 47957

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LETTERER-SIWE DISEASE

- Letterer-Siwe disease. (multisystem disease with risk organ involvement)
- This syndrome (10% of LCH cases), a systemic disorder, is the most severe form of Langerhans cell histiocytosis.
- Typically, a child < 2 years presents with a scaly seborrheic, eczematoid, sometimes purpuric rash involving the scalp, ear canals, abdomen, and intertriginous areas of the neck and face.
- Denuded skin may facilitate microbial invasion, leading to sepsis.
- Frequently, there is ear drainage, lymphadenopathy, hepatosplenomegaly, and, in severe cases, hepatic dysfunction with hypoproteinemia and diminished synthesis of clotting factors.
- Anorexia, irritability, failure to thrive, and pulmonary manifestations (eg, cough, tachypnea, pneumothorax) may also occur.
- Significant anemia and sometimes neutropenia occur; thrombocytopenia is of grave prognostic significance.
- Parents frequently report precocious eruption of teeth, when in fact the gums are receding to expose immature dentition.
- Patients may appear abused or neglected.

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TREATMENT: LANGERHANS CELL HISTIOCYTOSIS

- Supportive care
- Sometimes hormone replacement therapy for hypopituitarism, most commonly diabetes insipidus
- Chemotherapy for multisystem involvement, single system multifocal involvement, and involvement in certain sites such as skull-based lesions
- Sometimes surgery, corticosteroid injection, or rarely, radiation therapy (usually for unifocal bone involvement)
- Because these syndromes are rare and complex, patients are usually referred to institutions experienced in the treatment of Langerhans cell histiocytosis. The majority of patients should be treated using protocols developed by the Histiocyte Society

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PROGNOSIS: LANGERHANS CELL HISTIOCYTOSIS

- Prognosis is good for patients with Langerhans cell histiocytosis and both of the following:
 - Disease restricted to skin, lymph nodes, or bones
 - Age > 2 years
- Morbidity and mortality are increased in patients with multisystem involvement, particularly those with
 - Age < 2 years
 - Involvement of risk organs (the hematopoietic system, liver, or spleen)
 - Involvement of the zygomatic, sphenoid, orbital, ethmoid, or temporal bones denotes a category of CNS risk lesions that imparts a higher risk of neurodegenerative disease in the skull and front of the face.
- With treatment, the overall survival rate for patients with multisystem disease without risk organ involvement is 100%, but event-free survival is about 70%. Disease recurrence may occur. A chronic remitting and exacerbating course may occur, particularly among adults.

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CLOSING THOUGHTS ON THIS CASE:

DIFFERENTIAL DIAGNOSTIC CONSIDERATIONS IN CHILDREN AND ADOLESCENTS WITH BACK PAIN.

- Stress reaction/fracture of the pars and posterior elements is a common condition in adolescents (**probably the M.C. pathology**)
- Treatment with CMT is not indicated in the “Active” phase when MRI shows edema.

Chiropractors must keep this diagnosis in the forefront when working with **adolescent patients** with back pain.

Children younger than ~12 yoa or pre-adolescent may have a different etiology of pain, besides stress fracture and this possibility must be kept in mind.

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NEXT CASE

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CASE 1 NEW MOM

- 26 yoa female
- 6 wks post-partum
- Healthy infant
- Back pain began a couple of weeks prior to presentation.
- Pain with bending and lifting. Increased pain to stand from sitting.
- No falls
- No lower extremity symptoms.
- Prior history + for mini stroke at age 21 from birth control. No neurologic residual.

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- Back pain, significant enough that side posture positioning for manipulation not tolerated.
- Flexion/distraction motion of Leander table not well tolerated.
- Passive therapies and stretching used mostly.
- Patient treated for ~ 3 weeks (therapy interrupted, due to doctor out of town and patient out of town at different times).
- Not responsive to care.
- MRI ordered.

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ORDERING/ OBTAINING IMAGING WHEN NEEDED.

- Plain films are commonly the starting point.
- Advanced imaging may be indicated through patient symptoms or clinical signs.
 - MRI
 - C.T.
 - Ultrasound
 - Radionuclide imaging: Bone Scan / PET scan.
 - Contrast studies (Barium studies for G.I. / IV contrast – CT or MRI)
 - Mammography
 - DEXA

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RADIOGRAPHIC FINDINGS:

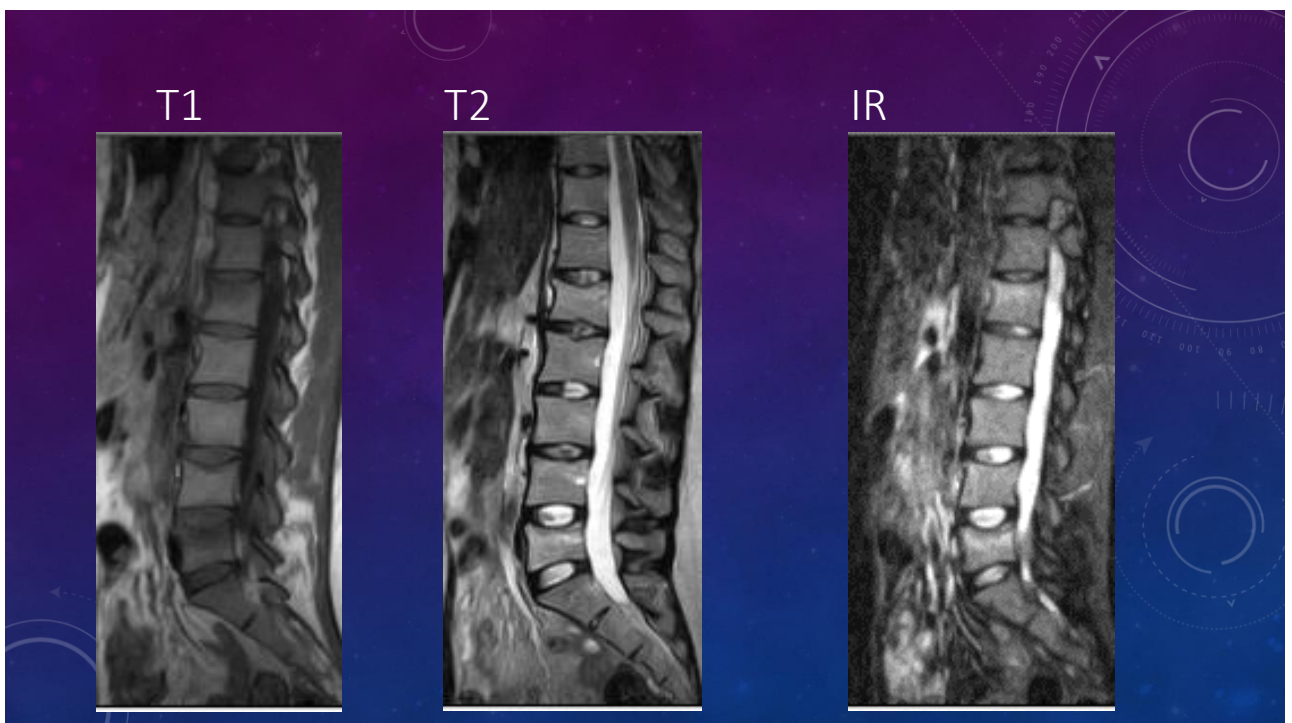
- No evidence of fracture or dislocation.
- Vertebral body heights are preserved.
- Lumbar lordosis is reduced.
- Slight right lateral lumbar list.
- SI joints preserved.
- Osteopenia noted. ? Technical in nature or real ?

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MRI ORDERED

- Due to continued pain and inability to move/ bend/ lift without pain.
- MRI of lumbar spine ordered.

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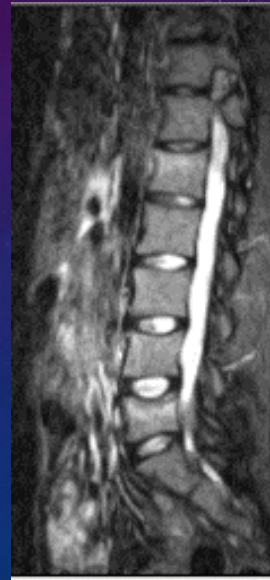
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- T1 MRI
- Compared with
- Lateral Lumbar x-ray
- Endplate depressions
- More notable on MRI

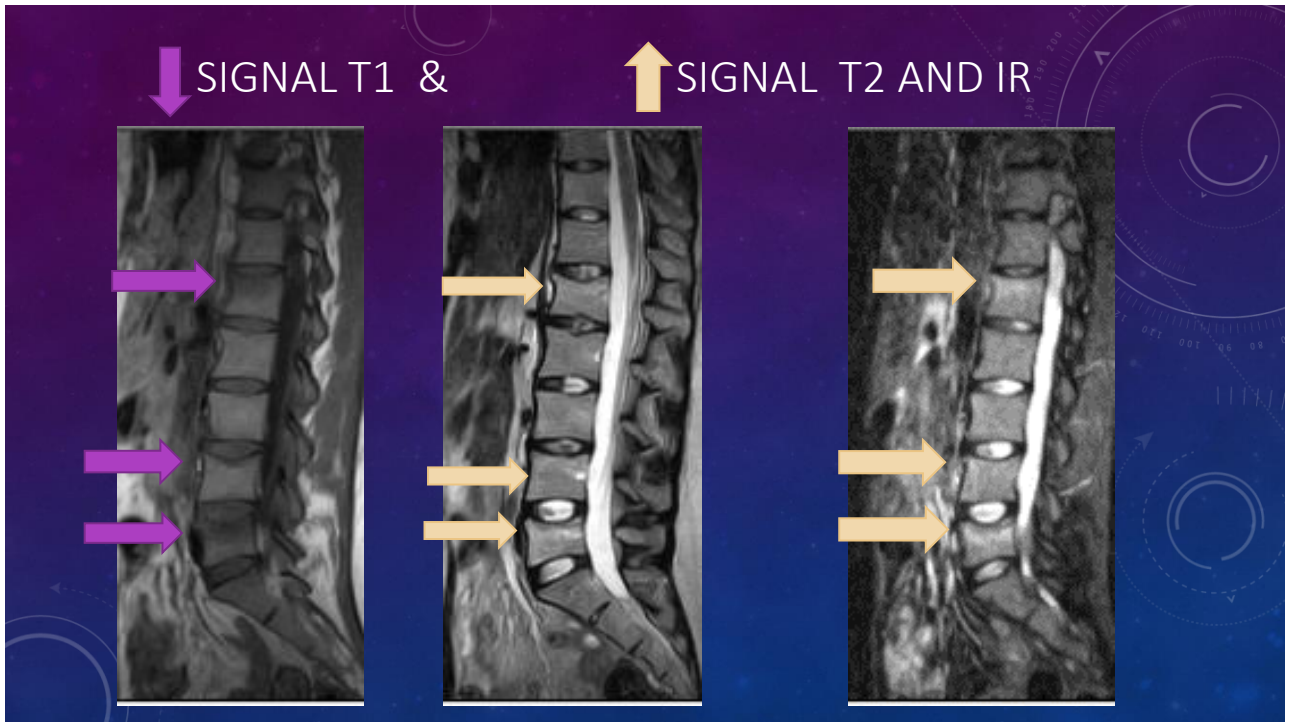


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SUPERIOR ENDPLATE DEPRESSIONS AT L1, L4, AND L5



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Review of radiographs and MRI findings

- Plain films:
 - Osteoporosis.
 - Vertebral body heights preserved.
- MRI:
 - Superior endplate depressions at L1, L4, and L5.
 - Edema is also present in the sub-endplate zones of the vertebral bodies
 - Findings are consistent with osteoporotic compression deformities.

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FURTHER DISCUSSION WITH PATIENT.

Why does patient's spine look like a 70 year old –
Osteopenia on X-ray and compression deformities on MRI.

Consider causes of why 26 year old female has osteoporotic
type compressions in her spine.

Pregnancy is a risk factor for osteoporosis.

Medical conditions

Medications

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COMMON MEDICATION CAUSES OF OSTEOPOROSIS

Steroid therapy (prednisone)

Breast Cancer Drugs (aromatase inhibitors),

Prostate Cancer Drugs (Androgen deprivation therapy)

Heart Burn Medications (proton pump inhibitors and Aluminum containing antacids)

Depo-Provera (contraceptive)

Excessive Thyroid Hormone replacement (i.e. Synthroid)

Anti-Seizure and Mood altering drugs (Tegretol, Dilantin)

Diuretics (Lasix)

Prostate drugs (Flomax)

Anti-rejection/ immunosuppressive therapy (cyclosporine)

Heparin therapy (blood thinners)

Chemotherapy drugs – result in lower testosterone levels

SSRI's Serotonin reuptake inhibitors (fluoxetine, sertraline, paroxetine, citalopram)

Diabetes Med - insulin sensitizers (Thiazolidinediones)

- <https://osteoporosis.ca/about-the-disease/what-is-osteoporosis/secondary-osteoporosis/medications-that-can-cause-bone-loss-falls-andor-fractures/>

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QUESTION OF MEDICATIONS / OTHER CAUSES OF OSTEOPOROSIS AT YOUNG AGE.

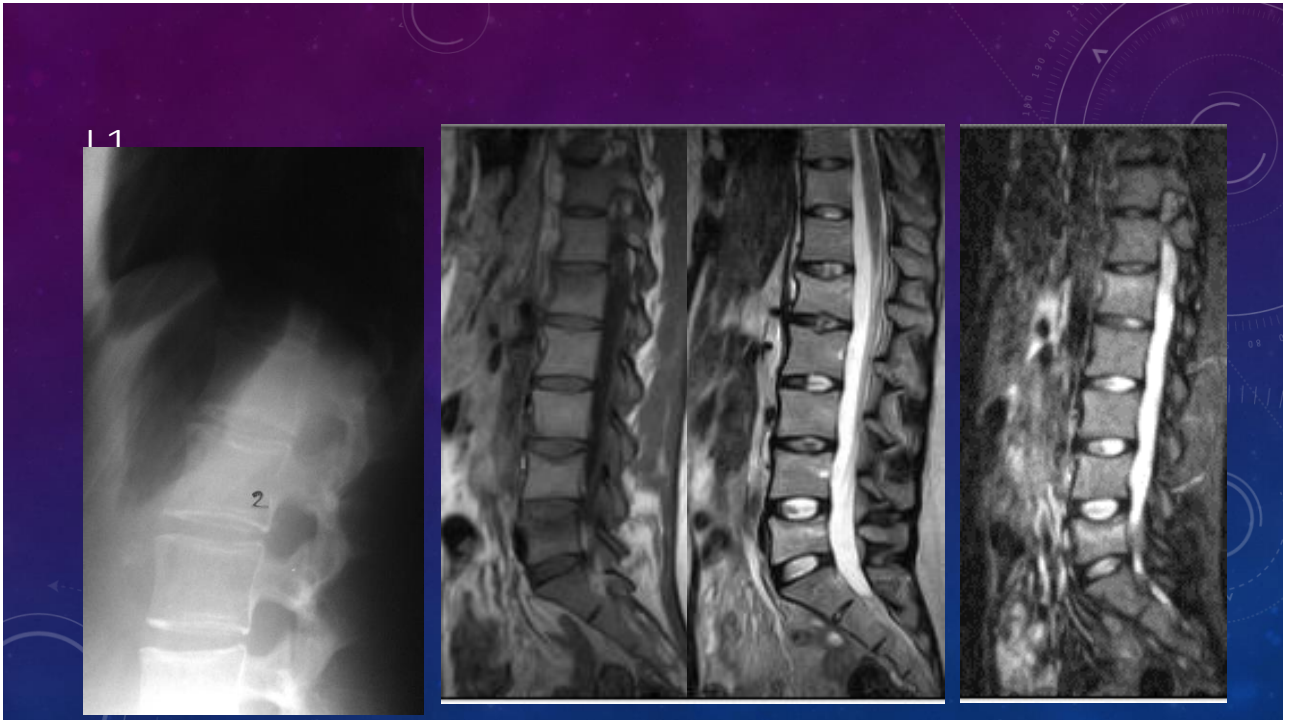
- Patient was treated with heparin and a low molecular weight heparin alternative (Lovenox) during pregnancy to prevent recurrence of thrombosis related to pregnancy, due to her prior history.
- Stopped taking heparin prior to visit at chiropractic office, so she didn't put it down as a medication on her history form.

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“SIDE NOTE” FROM EPOCRATES

- Lovenox:
- Black box warnings
 - Spinal / epidural hematomas. May occur in anticoagulated pts. Receiving neuraxial anesthesia or spinal puncture. Hematoma may result in long term or permanent paralysis; increased hematoma risk if indwelling epidural catheter use, concomitant use of drugs affecting hemostasis including NSAIDs, platelet inhibitors, or other antcoagulants, traumatic or repeated epidural/spinal puncture hx, spinal deformity, or spinal surgery hx,

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HEPARIN OR LMWH INDUCED OSTEOPOROSIS

Lupus (2010) 19, 3–12

<http://lup.sagepub.com>

REVIEW

Low-molecular-weight heparin-induced osteoporosis and osteoporotic fractures: A myth or an existing entity?

E Lefkou, M Khamashta, G Hampson and BJ Hunt
Guy's & St Thomas' NHS, London, UK

Long-term use of unfractionated heparin data has been associated with a 2.2–5% incidence of heparin-induced osteoporotic fracture, but for low-molecular-weight heparin (LMWH) data is scarce and there is lack of clarity of the risks of osteoporosis and osteoporotic fractures. In this paper we review the differential diagnosis of osteoporosis and osteoporotic fractures, and we conduct a systematic review of all related cases from case reports and trials. Two new cases of possible LMWH-induced osteoporosis are also presented and the difficulties in making the diagnosis are highlighted. The authors conclude that, until large clinical trials are designed to investigate pre- and post-treatment bone density and to compare different dosages of LMWH effect on the bone density in different patient groups, no safe conclusions can be made. *Lupus* (2010) 19, 3–12.

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- 1. Expert Opin Drug Saf. 2005 May;4(3):583-90.
- Minimizing the risk of heparin-induced osteoporosis during pregnancy.
- Hawkins D, Evans J.
- South University, School of Pharmacy, 709 Mall Boulevard, Savannah, GA 31406, USA. dwhawkins@southuniversity.edu
- Abstract
- Unfractionated heparin (UFH) may lead to symptomatic vertebral fractures in up to 3 out of every 100 people on long-term therapy. Ten-times that many people will experience a significant reduction in bone density leading to osteopenia or osteoporosis. Low molecular weight heparins (LMWH) have been shown to be as effective as UFH in the prevention and treatment of venous thromboembolism. Several well-established advantages of LMWH over UFH include increased bioavailability, more predictable dose response, less intensive coagulation monitoring, and a lower probability of causing immune-mediated thrombocytopenia. There is also some evidence that long-term LMWH therapy is less likely to cause osteoporotic fractures and significant reductions in bone mass than UFH. Both UFH and LMWH undergo pharmacokinetic changes during pregnancy, which sometimes necessitates dosage adjustments. Fondaparinux is a synthetic antithrombotic agent, which specifically binds to antithrombin. It has been shown to be comparable to, or even more effective than, LMWH in the management of both arterial and venous thrombosis. Fondaparinux does not appear to have a negative effect on bone metabolism. Therefore, fondaparinux may be a safe and effective alternative to UFH and LMWH in women who require anticoagulation during pregnancy.

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REVIEW OF RADIOGRAPHS

The question I had: Did I miss something on the initial radiographs?

- Go back and review films: No evidence of compression deformities.
- =====
- MRI is more sensitive to disclosing change in anatomy due to sectional imaging.
- Vertebral compression fractures, endplate depressions, and Schmorl's nodes are more conspicuously shown on sectional imaging.

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NEXT CASE

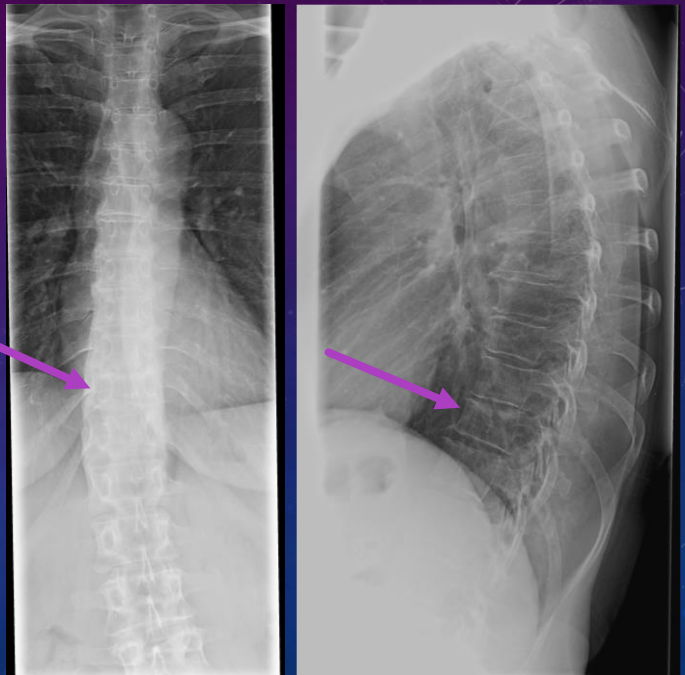
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54 YOA FEMALE:
BACK PAIN

T11 subtle compression

Fairly subtle finding:

patient sore at that level.
MRI recommended for
further evaluation.



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T2 SAGITTAL MRI

- More conspicuous endplate depression and edema.
- Edema indicates acute or active compression deformity.
- Fast Spin echo images show high signal Fluid/water and high signal sub Q fat.
- Hard to differentiate fluid vs fat.



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- T1 sagittal MRI
- Again, more conspicuous lesion
- on sagittal mri compared to x-ray



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- Inversion Recovery (IR) sagittal MRI
- IR images (water weighted images) differentiate water from fat.
- Fluid / water is bright and Sub Q fat is low signal



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NEXT CASE

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9 YOA BOY: HEADACHE

HA, loss balance and confusing history of possible fall from tree... 1 month ago or 6 months ago...

Repeat visits to MD and ER. *Pediatric visit for HAs but Ped. didn't want to do CT, due to too much radiation exposure.*

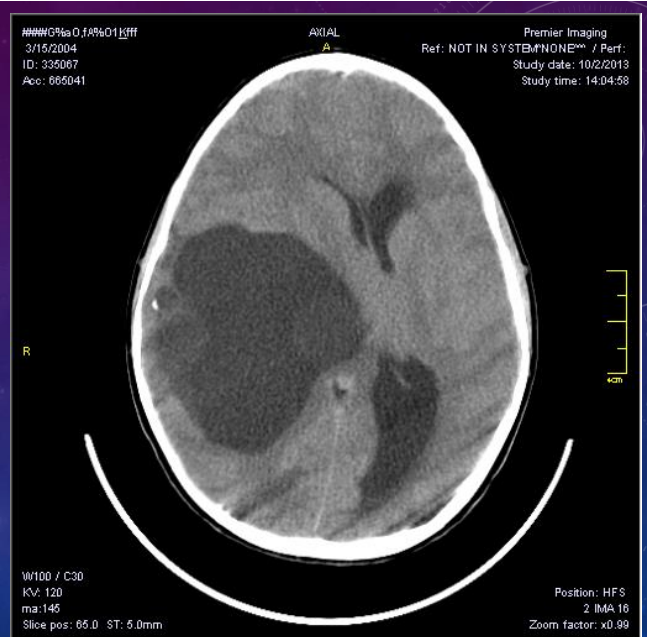
Parents brought him to D.C. and he took plain films of neck and saw shadow anterior to C1. (acutally rotated C1 due to patient rotation and head tilt, due to patient not being able to hold his head up well). DC didn't agree that the appearance on plain film was due to rotation, so he wanted further imaging. (I didn't have another other history other than fall from tree 3 weeks ago). So told him to get CT of the neck, to view upper vert.

When he ordered the neck CT, he decided to get a brain too. Good thing.

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9 YOA BOY: HEADACHE

DDX so far:
 ganglioglioma,
 DNET (Dysembryoplastic
 neuroepithelial tumour), pilocytic
 xanthoastrocytoma,
 and less likely
 oligodendroglioma.



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MED-LEGAL

- Considerations for malpractice
- Missed or delayed diagnosis

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HOW FINDINGS ARE MISSED

Imaging findings may be missed by:

Perceptual Errors:

- Cause of 70-80 % of missed findings
- Just don't see the finding, even though it is there.

Cognitive errors:

- See the finding but ignore it because;
- don't know what it means
- attribute it to something else
(normal variation or artifact)

Malpractice Issues in Radiology

Perceptual Errors and Negligence

Leonard Berlin¹ and Ronald W. Hendrix²

The Case

A 15-year-old boy was taken to his family physician because of a 1-week history of knee pain. The physician ordered a radiologic examination of the knee, which was interpreted by the radiologist as normal (Fig. 1). The physician prescribed antiinflammatory medication, but the patient's knee pain worsened. Three weeks later, the physician referred the boy to an orthopedic surgeon, who diagnosed the condition as "patellar pain syndrome." The surgeon prescribed exercises and a different antiinflammatory agent. Five weeks later (2 months after the initial radiograph) the boy fell while riding his bicycle and sustained a comminuted fracture of the distal femur. The orthopedic surgeon applied a plaster cast, which he removed 4 weeks later because the patient complained of increasing pain. When the cast was off, the orthopedic surgeon noticed a hard swollen mass proximal to the knee. Radiographs and MR imaging revealed a tumor of the distal femur with invasion of the adjacent soft tissues. A biopsy disclosed osteosarcoma. Because of the large size of the tumor and the extensive involvement of soft tissues aggravated by the fracture, limb salvage was not possible and a high femoral amputation was performed. The patient subsequently underwent chemotherapy and has remained tumor free for 6 years.

Medical-Legal Issues

The parents of the patient filed a malpractice lawsuit against the orthopedic surgeon and the radiologist, claiming that misinterpretation of the initial radiographs and subsequent misdiagnosis of patellar pain syndrome resulted in delayed diagnosis and treatment of the bone malignancy, so that limb salvage surgery became impossible and long-term prognosis was diminished. At trial, an expert radiologist retained by the plaintiff testified that the lesion in the distal femur was quite evident on the initial radiographs and that it was the opinion of the expert radiologist that the defendant radiologist was negligent because the lesion was not seen.

A radiology expert for the defense countered that the bone lesion was subtle and below the threshold of usual detectability. He acknowledged that he, as well as the attorneys and jurors, could now see the lesion after it had been pointed out to them, but that this fact had no relevance in determining whether not seeing the lesion initially was a breach of the standard of care. The radiology expert for the defense pointed out that radiology is not practiced retrospectively. He explained that in his opinion the defendant radiologist was not negligent because, on the initial radiographs, the tumor looked like a normal radiolucency frequently seen in the distal femur of a 15-year-old. The expert for

the defense suggested that searching for abnormality on a radiograph was like finding Waldo in one of the illustrations in the *Where's Waldo* books written by Handford [1, 2]. In those illustrations, the image of Waldo is first to find Waldo, but on finding him a second time, there is no difficulty finding him a second time. The expert defense emphasized the similarity of finding Waldo among a multitude of like images and finding an abnormal area among a multitude of shadows of density; both tasks are difficult. However, according to the expert for the defense, the image of Waldo or an abnormal area found, either image can then be seen and clearly in retrospect.

After the testimony ended, the jury deliberated and reached a verdict. It ruled in favor of the plaintiff, awarding both the orthopedic surgeon and the radiologist any liability [3].

Discussion

The question of whether a missed radiographic diagnosis constitutes malpractice perplexed radiologists, fascinated reviewers, and captured the attention of the public for decades. Beginning with the pioneering work of Garland alone almost half a century ago [4], a number of radiologic inves-

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Case summaries are based on actual events and lawsuits, although certain facts have been omitted or modified by the authors, who have supplied and obtained authorization for the use of the radiographic images. All opinions expressed herein are those of the authors and do not necessarily reflect those of the American Journal of Roentgenology or the American Roentgen Society.

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AJR 170, April 1998

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“With respect to mistakes or errors in radiographic diagnoses;

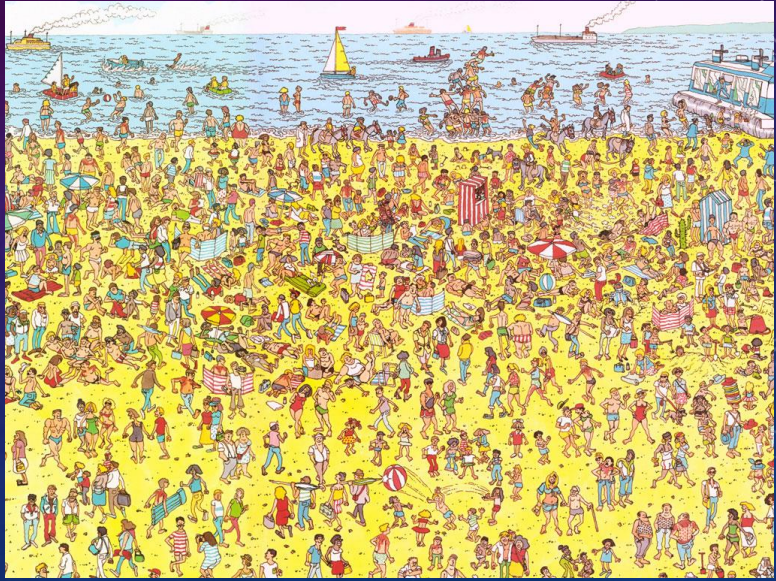
- some are cognitive-that is, they result from misinterpretation due to lack of knowledge or faulty reasoning.
- Perceptual errors, on the other hand, in which radiographic abnormalities are simply not seen by the radiologist on initial interpretation, are a far more common cause of radiographic mistakes, accounting for as many as 80% of them.”
- “The missing of an overt lesion remains as much a mystery and enigma today as it was 50 years ago.”

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- “The failure to detect a radiographic abnormality is often attributed to the subtlety of the radiographic finding. or its poor conspicuity, a term defined by Potchen and Bisesi, as the ratio between the contrast enhancement of the lesion or edge relative to the surrounding tissues.”
- “While this definition may adequately explain how a truly subtle lesion can be missed, it is woefully inadequate to explain how an obvious abnormality can be missed.”

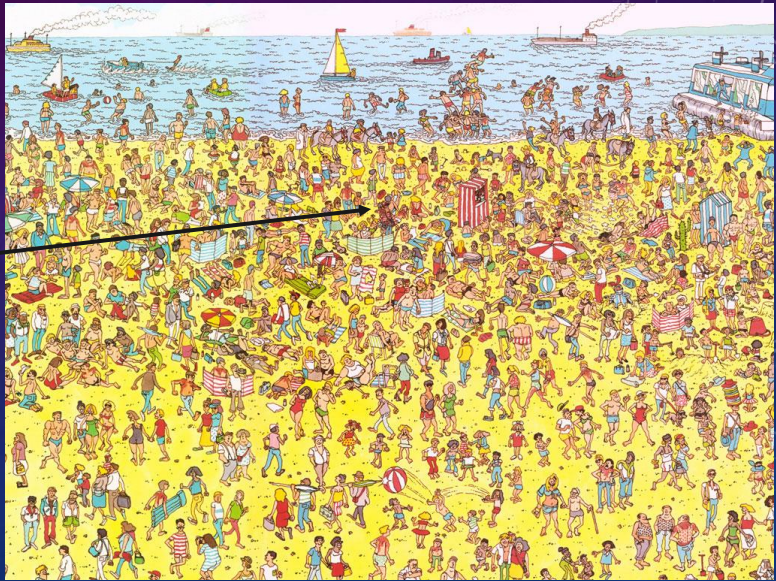
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WHERE'S WALDO



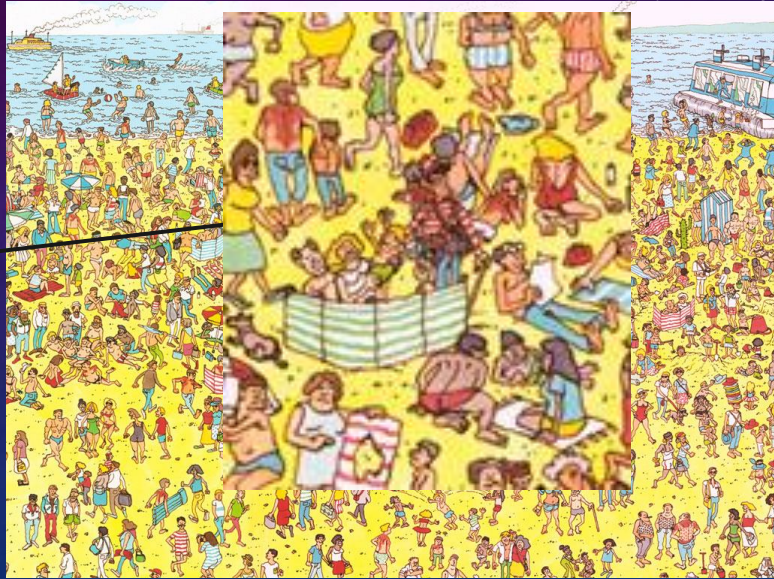
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WHERE'S WALDO



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WHERE'S WALDO



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WHERE'S WALDO

- Findings on imaging may be missed, just as the Waldo may be overlooked on those cartoon challenges where one tries to find Waldo, in a sea of similar appearing figures.
- Once Waldo is found, going back to see him again is easy. Just as going back to an x-ray, knowing where the abnormality is, then it will be easily seen.
- Radiology interpretation is not practiced retrospectively. We must be able to discover Waldo on the initial reading.
- Several factors affect our interpretation accuracy: Interruptions – phone, staff, patients, and any other concentration breakers.

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ADDITIONAL FACTORS THAT RESULT IN ERRORS IN DIAGNOSIS.

- Not getting imaging in the first place.
- Not getting the right images (incomplete series or images of the wrong body region)
- Technical problems: bad films – technical factors, plain films and digital processing errors, patient body habitus, overlying artifacts, patient positioning errors –upright bucky for an ankle study.

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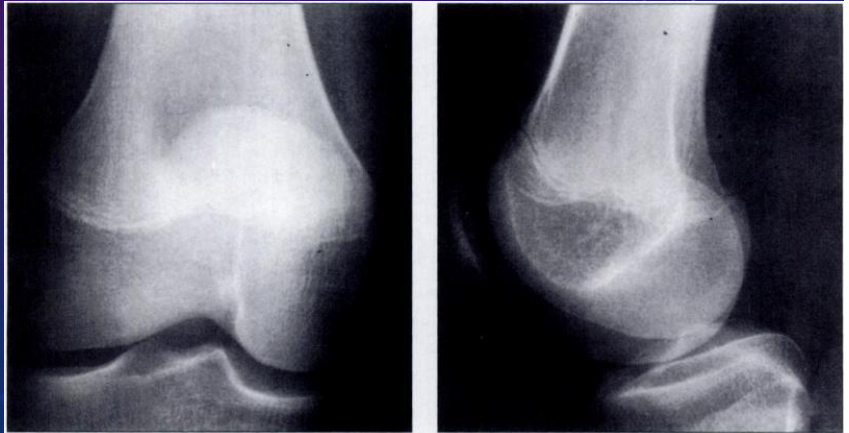
PERCEPTUAL ERRORS AND NEGLIGENCE

ARTICLE: BERLIN AND HENDRIX. AJR:170, APRIL 1998

- 15 yoa Male. 1 week pain
- PCP saw pt. Ordered x-ray, read as “normal”
- PCP - RX anti-inflammatory,
- 3 weeks pain continued
- Referred to orthopedist
- Dx as Patellar pain syndrome.
- Changed anti-inflammatory med. and Rx exercises

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- 5 weeks later (8 weeks Pain)
- Patient fell while riding bike
- Fx distal femur.
- Plaster cast applied, but continued pain and 4 weeks later cast removed due to swelling
- Tumor found:
 - Osteosarcoma.
- Leg amputation.
- Family sued for missed DX on x-ray.
(radiolucent lesion In metaphysis)



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CORRELATION OF HISTORY AND CLINICAL INFORMATION

- Correlation history and clinical information with physical exam for determination of need for imaging.
- If manipulation is contemplated as a treatment method, then imaging may be needed.
- Pain severe enough that patient cannot weight bear, then imaging may be needed.
- Night pain, pain with rest, fever, etc.
- Overt trauma and visible deformity following trauma.
- Repetitive trauma

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CORRELATION OF HISTORY AND CLINICAL INFORMATION

- Lower Back Pain – Imaging Guidelines:
- Age > 50 years
- Significant trauma
- Neuromotor deficits
- Unexplained weight loss (10 lb in six months)
- Suspicion of ankylosing spondylitis
- Drug or alcohol abuse // Use of corticosteroids
- History of cancer
- Temperature $\geq 37.8^{\circ}\text{C}$ (100.0°F)
- Recent visit (within 1 month) for same problem and no improvement
- Patient seeking compensation for back pain
- Deyo RA, Diehl AK. Lumbar spine films in primary care: current use and effects of selective ordering criteria. J Gen Intern Med 1986;1:20–5. and <http://www.aafp.org/afp/1999/1115/p2299.html>

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THE TAKE AWAYS.

- Do your own work – Good history and exam, even if patient has been to another provider.
 - The other provider may have not performed exam or the patient's condition could have changed in the interim.
- Order or get imaging when indicated.
- Quality radiographs are required.
- Careful attention to detail in your history, exams, and review of imaging.
- Don't get hung up on guidelines or "Radiophobia."

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- The END

- Thank you !