Diagnostic Imaging Utilization

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Your instructor

Jack Miller BSc(PT), Dip MT (NZ), MClSc, DPT, FCAMPT

Jack completed his BSc in Physical Therapy at the University of Toronto. He then spent six years in Australia and New Zealand where he completed an advanced specialty Diploma of Manipulative Therapy. During this program he was directly mentored by both Robin McKenzie and Brian Mulligan. On returning to Canada he competed a Masters of Clinical Science at Western University and a Doctor of Physical Therapy Degree from the University of St. Augustine.

Jack has been the senior editor of the Canadian Physiotherapy Association's Orthopaedic Journal, an executive member of the Orthopaedic Division of CPA, the President of the Canadian Academy of Manipulative Physical Therapy, a founding member of the Mulligan Concept Teacher's Association and a member of the CPA's Specialization accreditation committee.

Jack currently works as an Advanced Practice Physiotherapist in Ontario and is a Co-Director of Key Clinical Skills.

MEDICAL DIAGNOSTIC IMAGING UTILIZATION

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The course

Recommendations:

- Download the course handouts
- Follow along and make notes on the handouts
- Take your time – you have 10 weeks
- View the units several times (you can go back multiple times)
- Let us know if we have made any mistakes (we are not quite perfect yet)
- Enjoy the course and tell others

MEDICAL DIAGNOSTIC IMAGING UTILIZATION

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The plan

Unit 1
- Legalities

Unit 2
- Ordering testing

Unit 3
- Errors in testing

Unit 4
- CAR 1

Unit 5
- CAR 2

Unit 6
- ACR Upper limb

Unit 7
- ACR Lower limb

Unit 8
- ACR Spine

Unit 9
- Clinical indications

Unit 10
- Case studies & resources

MEDICAL DIAGNOSTIC IMAGING UTILIZATION

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Utility vs utilization

Utility

What does it do?

Utilization

How to use it effectively

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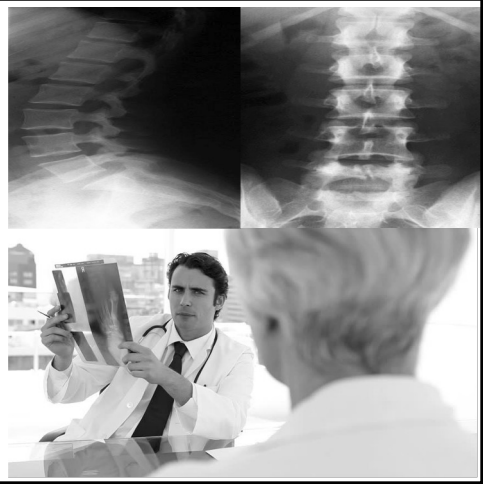
Utility vs utilization

Utility

What does it do?

Utilization

How to use it effectively



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MD awareness of radiation exposure

Equivalent number of doses of radiation for most commonly requested investigations. Dose for chest x ray used as single unit dose of radiation. Figures are numbers (percentage) of doctors with correct answer for each investigation

Radiological investigation	Equivalent No of chest x rays	No of correct answers (n=130)
Abdominal x ray	75	2 (1.5)
Lumbar spine x ray	120	3 (2)
Thoracic spine x ray	50	4 (3)
Barium swallow	100	6 (5)
Peroperative cholangiogram	65	3 (2)
Fixation of fractured neck of femur	45	10 (8)
Ultrasound of abdomen	0	124 (95)
CT of abdomen	400	8 (6)
Spiral CT of abdomen	300	9 (7)
MRI of abdomen	0	119 (92)
MRI of knee	0	119 (92)
MRI of spine	0	119 (92)
Leg arteriogram	400	0
Renal arteriogram	80	1 (1)
Thyroid isotope scan	50	8 (6)
White cell scan	150	2 (1.5)

Shiralkar 2003

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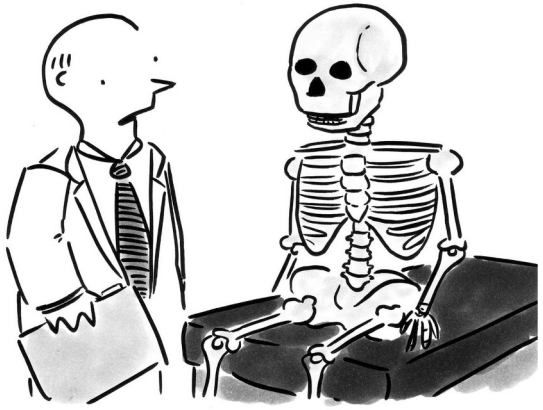
Utilization of imaging

Systematic review

19 million low back consultations

- Received imaging
  - Primary care: 25%
  - Emergency departments 33%

Downie 2020



"Still, let's do an x-ray just to be sure."

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Utilization of Lumbar Radiography

- Single most over-requested diagnostic imaging procedure
  - –Economic impact
  - –Irrelevant findings that lead to inappropriate diagnosis and treatment
- Degenerative changes present in 28 to 50% of population
  - –Excessive gonadal radiation

ACR 2022

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Clinical practice guidelines for imaging

- Don't do imaging for lower-back pain unless red flags are present
- Don't do imaging for minor head trauma unless red flags are present
- Don't do imaging for uncomplicated headache unless red flags are present
- Don't do ankle x-ray series in adults for minor injuries

https://choosingwiselycanada.org/radiology/

CAR 2020

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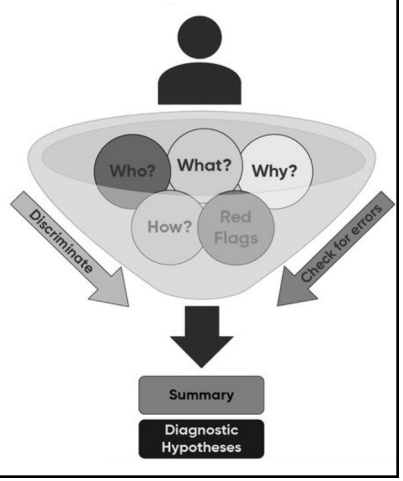
Utilization of Radiography

Plain films or conventional radiographs

- Radiographs will routinely identify "pathology"
- High prevalence of "findings" in asymptomatic population
- Imaged pathology must be placed in the appropriate clinical context with:
  1. A detailed history
  2. A thorough physical exam
  3. **Sound clinical reasoning**



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Practice integration

Unit 1

Legalities of diagnostic imaging in Canada

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Legalities

Alberta

- Physiotherapists are eligible to seek authorization to ***order*** the following forms of ionizing or non-ionizing radiation:
  - X-rays
  - Magnetic resonance imaging
  - Ultrasound imaging
- There are no provisions within physiotherapy legislation to enable physiotherapists to ***apply*** ionizing or non-ionizing radiation in any form.
- For full details of this please visit: https://www.cpta.ab.ca

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Legalities

Ontario

- Bill 179 allowing physiotherapists to order diagnostic imaging and laboratory tests fully passed by legislature 2009.
- Awaiting full enactment
- For full details of this please visit: https://www.collegept.org

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Legalities

Quebec

- Physiotherapists who have achieved "Attestation" with the Order of Professional Physiotherapists of Quebec (OPPQ)
- May order plain radiographs under specific circumstances.
- For full details of this please visit: https://oppq.qc.ca/en/

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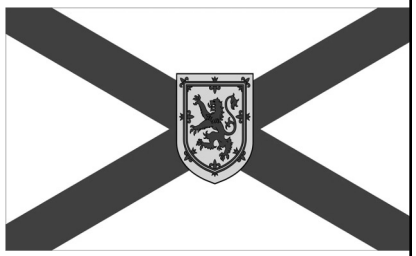
Legalities

Nova Scotia

- Physiotherapists in Nova Scotia
- May order diagnostic imaging within their scope of practice
- Requirements:
- Demonstration of:
  - Theoretical knowledge
  - Practical knowledge
  - Limits of imaging studies
- https://nsphysio.com



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Legalities

When in doubt consult with your regulatory college professional practice advisor regarding scope of practice, delegation and rostering for controlled acts.

CPTBC College of Physical Therapists of British Columbia
Ordre professionnel de la physiothérapie du Québec
College of Physiotherapists of Alberta
College of Physiotherapists of New Brunswick / Collège des physiothérapeutes du Nouveau-Brunswick
SCPT Saskatchewan College of Physical Therapists
Prince Edward Island College of Physiotherapy
College of Physiotherapists of Manitoba
Nova Scotia College of Physiotherapists
College of Physiotherapists of Ontario
NLCP Newfoundland and Labrador College of Physiotherapists

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Legalities

- Are you directly ordering the test?
- Have you undertaken training to perform rostered activity?
- Are you competent to perform the rostered activity?
- Have you rostered for the activity with your regulatory college?

CPO 2023

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Legalities

Orders (AKA prescription)

- An order is a direction from a regulated health professional with legislative ordering authority (ie. physician to pharmacist)
- Generally written but may be verbal, electronic, faxed
- Verbal orders can be used but are not recommended in multi-practitioner settings

HPRO 2023

For full details of the current regulations we recommend you visit: http://www.regulatedhealthprofessions.on.ca/orders%2c-directives%2c-delegation.html

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Legalities

Delegation (AKA Medical directives)

- A health professional authorized to perform a controlled act
- Confers that authority to someone who is not so authorized.
- Delegation should be conferred and established by an written "standing order"

HPRO 2023

For full details of the current regulations we recommend you visit: http://www.regulatedhealthprofessions.on.ca/orders%2c-directives%2c-delegation.html

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Medical directives

Presenting Complaints	Order	Indications/Contra-indications
Pain or Injury to Lumbar Spine	APP may implement an order for any of the following tests, if indicated after physical assessment: X-ray AP/LAT of Lumbar Spine, upright if patient able X-ray AP/LAT Lumbar Spine supine If assessing stability following L-spine injury or pre-operative assessment for degenerative instability, APP may implement an order for: X-ray Flex-Ext Lumbar Spine	**Indications:** Trauma, fall, direct blow, pain NYD, pre-operative baseline Clinical findings: "red flags", i.e. progressive neurologic deficit **Contra-indications:** Patient refusal Pregnant **Guidelines:** APP will discuss with MD after writing orders to report findings and to discuss further diagnostic or management plan

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Medical directives

Presenting Complaints	Order	Indications/Contra-indications and Guidelines
Ankle Fracture or Ankle Pain	APP may implement an order for any of the following tests, if indicated after physical assessment: • AP/LAT/mortise views ankle	**Indications:** • Trauma, pain NYD, pre- and post-reduction, post- operative check **Contra-indications:** • Patient refusal **Guidelines:** APP will discuss with MD after writing orders to report findings and to discuss further diagnostic or management plan

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Legalities

1. Authority and Responsibility

Physiotherapists must have the authority to perform a controlled or legally restricted act. They get this authority from legislation, delegation, or a transfer of authority.

- Every ***controlled act**** performed by a physiotherapist must be within the scope of practice of physiotherapy.
- Physiotherapists are responsible both for deciding to offer a controlled act and for performing it.
- Physiotherapists who are asked by the College must be able to show that they meet the requirements in this standard.

CPO 2023

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Legalities

2. Education and Training

Physiotherapists must be able to prove that they have successfully completed training for the controlled acts they perform. This can be formal education or training delivered on the job. During the training, the physiotherapist must:

- Learn the indications, contraindications, adverse outcomes, and risks associated with performing the controlled act.
- Practise the controlled act under the supervision of a person who is authorized to perform it.
- Be evaluated on the knowledge, judgement, and practical skills needed to perform the controlled act.
- Show that they are able to safely and competently perform the controlled act.

CPO 2023

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Legalities

3. Managing Adverse Outcomes

Physiotherapists must know what to do if performing a controlled act results in an adverse outcome. Physiotherapists must have written instructions that tell them how to manage adverse outcomes that can be reasonably foreseen.

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Legalities

4. Communication with Other Health Care Providers

Physiotherapists may perform controlled acts that affect the care their patients receive from other health professionals. They must communicate with these professionals in a timely way.

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Scope of practice of Physiotherapy

Nova Scotia College of Physiotherapists

Radiography Study Views within Physiotherapist Scope March 2023

- Finger - AP/PA, Lateral
- Hand - AP/PA, Oblique, Lateral
- Wrist - AP/PA, Oblique, Lateral
- Forearm - AP and Lateral
- Elbow - AP and Lateral
- Humerus - AP and Lateral
- Shoulder - AP, Y view and axial
- Acromioclavicular joint - AP with and without weights
- Clavicle - AP and Axial
- Scapula - AP and Y View
- Toes - AP/PA, Oblique, Lateral
- Foot - AP/PA, Oblique, Lateral
- Calcaneus - Axial and lateral
- Heel – Harris Heel
- Ankle - AP/PA, Oblique, Lateral
- Tibia/Fibula - AP and Lateral
- Knee
  - AP (both knees) and Lateral affected
  - Skyline must be specifically requested as clinically relevant)
  - For suspected knee OA, weight-bearing required
- Femur - AP and Lateral
- Hip - AP (both hips) and Lateral affected
- Hips – Frog leg
- Pelvis - AP
- Cervical spine - AP, Odontoid, Lateral, both obliques if part of standard routine
- Thoracic spine - AP, Lateral and Swimmer's view
- Lumbar spine - AP, Lateral, L5S1
- Spine – EOS, scoliosis series
- Sacrum - AP and Lateral
- Coccyx - Lateral
- Sacroiliac joint - AP and both obliques
- Chest for rib views - PA and Oblique

CPO 2023

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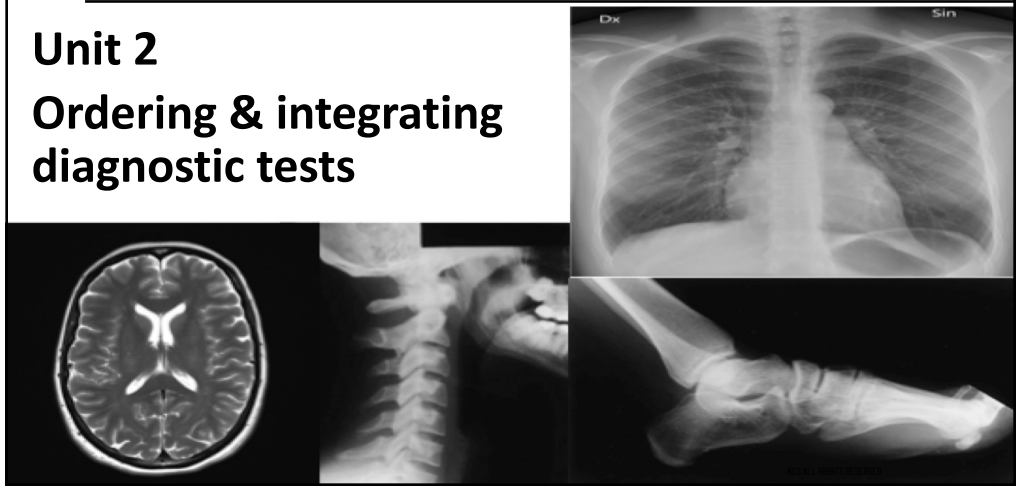
Diagnostic Imaging Utilization

Unit 2

Ordering & integrating diagnostic tests



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Stop and ask yourself these 10 questions

1. Is there potential of harm from ordering this test?
2. Is there potential of harm from not ordering this test?
3. Have I taken a full patient history?
4. Have I completed a comprehensive physical examination?
5. Can I make an accurate diagnosis and treatment plan based on the information I have gathered at a clinical level?

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Stop and ask yourself these 10 questions

6. Do I have a clear indication to order this test?
7. Will test results significantly change my management plan?
8. Are there suspected undiagnosed medical pathologies?
9. What is my plan to manage the test outcomes?
10. Am I the right clinician to be taking on this role?

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Is the radiology requests complete?

145 requests for medical imaging in a tertiary hospital

- Patient's last name: 100%
- Exam requested: 100%
- Patient's age: 90.3%
- Detailed clinical history: 18.2%
- Non-universal abbreviations: 100%

Akinola 2009

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Ordering imaging

Essential information on imaging order

- Patient name and contact information
- Referring clinician's name and contact information
- Brief clinical summary detailing need for imaging
  - Mechanism of injury
  - Anatomical location
  - Results of clinical tests

Keil 2021

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Ordering imaging

Essential information on imaging order

- Neurovascular status
- Results from prior imaging studies
- Hypothesized clinical diagnosis
- Study being requested & specialty views
- Statement on urgency of results if needed sooner than routine reporting timeline

Keil 2021

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Imaging requisition forms

MEDICAL IMAGING OUTPATIENT XRAY REQUISITION

Please see reverse for Medical Imaging facilities and hours of operation in your area.

Allergies: Yes ☐ Specify:
Order Date:
Sex: Male ☐ Female ☐
Pregnant: Yes ☐ No ☐
Name:
PHN: DOB:
Phone: Day Phone:
Address:
Is this exam: WCB ☐ #_____ Insurer: MSP ☐
Routine ☐ ASAP ☐ BCCA ☐ 3rd Party ☐ SELF PAY ☐
Requesting Dr. & Billing #: Dr. Signature
You MUST bring this requisition and your Care Card with you to the X-RAY department
Copies to:
RELEVANT HISTORY/ REASON FOR EXAM:
Rebalance MD Referral: ☐
Specialist Standing Order: On file with Medical Imaging ☐

CHEST
Chest (PA & Lat) ☐
Chest AP/PA Only ☐
Inspiration/Expiration ☐
Ribs (incl. PA Chest) L ☐ R ☐
Sternum ☐

ABDOMEN
Abdomen – Supine ☐
Abdomen - Supine/ Erect ☐
Abdomen - 2 views + PA Chest ☐
K.U.B ☐

SPINE & PELVIS
Cervical Spine ☐
Flexion-Extension ☐
Thoracic Spine ☐
Lumbar Spine ☐
Spine- specified additional views ☐
Pelvis ☐
Sacrum ☐
Coccyx ☐
Sacro-Iliac Joints ☐
Scoliosis ☐

MISCELLANEOUS
Skeletal Survey ☐
Diver's Medical ☐

UPPER EXTREMITIES (L R or Both)

	L	R
AC Joints	☐	☐
Clavicle	☐	☐
Elbow (ap/lat/obl)	☐	☐
Elbow (ap/lat)	☐	☐
Finger (ap/lat/obl)	☐	☐
Finger (ap/lat)	☐	☐
Forearm	☐	☐
Hand (ap/lat/obl)	☐	☐
Hand (ap/lat)	☐	☐
Humerus	☐	☐
Scaphoid & Wrist	☐	☐
Scapula	☐	☐
Shoulder (ap/ax/tscap)	☐	☐
Shoulder (ap/lat)	☐	☐
SC Joints	☐	☐
Wrist (ap/lat/obl)	☐	☐
Wrist (ap/lat)	☐	☐

HEAD & NECK
Mandible ☐
Facial Bones ☐
Orbits ☐ Pre MRI ☐
Nasal Bones ☐
Paranasal Sinuses ☐
Nasopharynx and/or neck soft tissues ☐

LOWER EXTREMITIES (L R or Both)
Weight bearing exam? Yes ☐

	L	R
Ankle (ap/lat/obl)	☐	☐
Calcaneus (ax/lat/obl)	☐	☐
Calcaneus (ax/lat)	☐	☐
Femur	☐	☐
Foot (ap/lat/obl)	☐	☐
Foot (ap/lat)	☐	☐
Hip	☐	☐
Knee (ap/lat)	☐	☐
Oblique	☐	☐
Patella	☐	☐
Tunnel	☐	☐
Tibia & Fibula	☐	☐
Toe (ap/lat/obl)	☐	☐
Toe (ap/lat)	☐	☐
Leg Length	☐	☐

OTHER:

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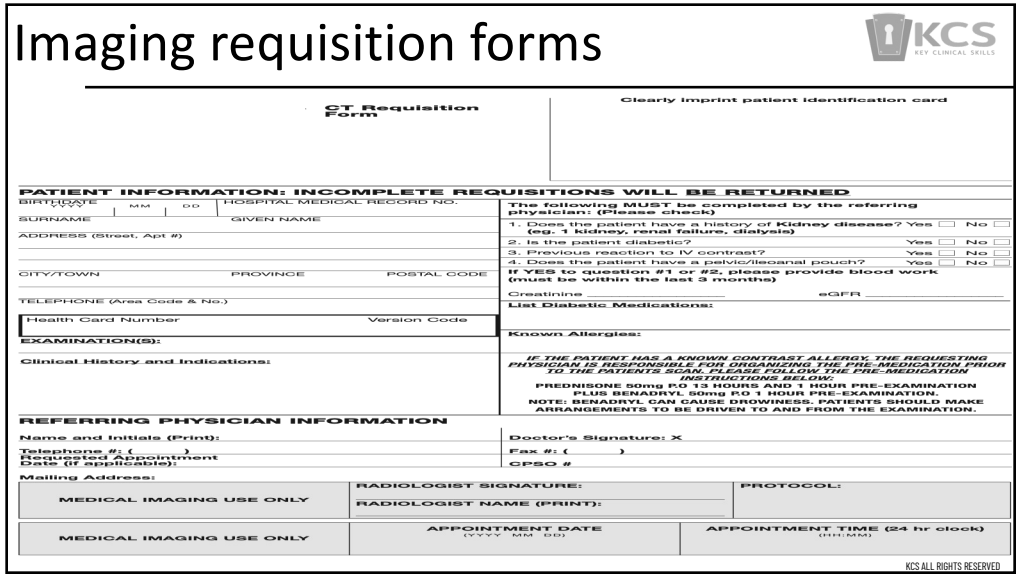
Imaging requisition forms



CT Requisition Form

Clearly imprint patient identification card

PATIENT INFORMATION: INCOMPLETE REQUISITIONS WILL BE RETURNED

BIRTHDATE (YYYY MM DD) | HOSPITAL MEDICAL RECORD NO.

SURNAME | GIVEN NAME

ADDRESS (Street, Apt #)

CITY/TOWN | PROVINCE | POSTAL CODE

TELEPHONE (Area Code & No.)

Health Card Number | Version Code

EXAMINATION(S):

Clinical History and Indications:

The following MUST be completed by the referring physician: (Please check)

1. Does the patient have a history of **Kidney disease**? Yes ☐ No ☐ **(eg. 1 kidney, renal failure, dialysis)**
2. Is the patient diabetic? Yes ☐ No ☐
3. Previous reaction to IV contrast? Yes ☐ No ☐
4. Does the patient have a pelvic/ileoanal pouch? Yes ☐ No ☐

If YES to question #1 or #2, please provide blood work (must be within the last 3 months)

Creatinine _____ eGFR _____

List Diabetic Medications:

Known Allergies:

IF THE PATIENT HAS A KNOWN CONTRAST ALLERGY, THE REQUESTING PHYSICIAN IS RESPONSIBLE FOR ORGANIZING THE PRE-MEDICATION PRIOR TO THE PATIENTS SCAN. PLEASE FOLLOW THE PRE-MEDICATION INSTRUCTIONS BELOW:

PREDNISONE 50mg PO 13 HOURS AND 1 HOUR PRE-EXAMINATION PLUS BENADRYL 50mg P.O 1 HOUR PRE-EXAMINATION.

NOTE: BENADRYL CAN CAUSE DROWINESS, PATIENTS SHOULD MAKE ARRANGEMENTS TO BE DRIVEN TO AND FROM THE EXAMINATION.

REFERRING PHYSICIAN INFORMATION

Name and Initials (Print):

Telephone #: ( )

Requested Appointment Date (if applicable):

Mailing Address:

Doctor's Signature: X

Fax #: ( )

CPSO #

MEDICAL IMAGING USE ONLY	RADIOLOGIST SIGNATURE: / RADIOLOGIST NAME (PRINT):	PROTOCOL:
MEDICAL IMAGING USE ONLY	APPOINTMENT DATE (YYYY MM DD)	APPOINTMENT TIME (24 hr clock) (HH:MM)

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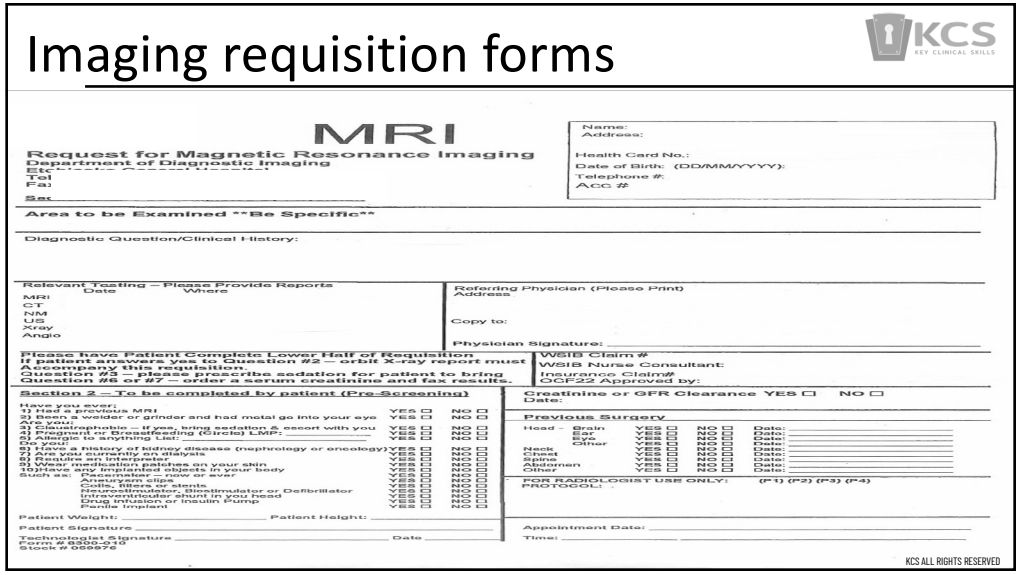
Imaging requisition forms



MRI

Request for Magnetic Resonance Imaging

Department of Diagnostic Imaging

Name:
Address:
Health Card No.:
Date of Birth: (DD/MM/YYYY):
Telephone #:
Acc #

Area to be Examined **Be Specific**

Diagnostic Question/Clinical History:

Relevant Testing – Please Provide Reports

	Date	Where
MRI		
CT		
NM		
US		
X-ray		
Angio		

Referring Physician (Please Print)
Address

Copy to:

Physician Signature: _____

Please have Patient Complete Lower Half of Requisition.
If patient answers Yes to Question #2 – orbit X-ray report must accompany this requisition.
Question #5 – please prescribe sedation for patient to bring
Question #6 or #7 – order a serum creatinine and fax results.

WSIB Claim #
WSIB Nurse Consultant:
Insurance Claim#
OCF22 Approved by:

Section 2 – To be completed by patient (Pre-Screening)

Have you ever:
1) Had a previous MRI YES ☐ NO ☐
2) Been a welder or grinder and had metal go into your eye YES ☐ NO ☐
Are you:
3) Claustrophobic – If yes, bring sedation & escort with you YES ☐ NO ☐
4) Pregnant or Breastfeeding (Circle) LMP: _____ YES ☐ NO ☐
5) Allergic to anything List: _____ YES ☐ NO ☐
Do you:
6) Have a history of kidney disease (nephrology or oncology) YES ☐ NO ☐
7) Require Dialysis YES ☐ NO ☐
8) Require an Interpreter YES ☐ NO ☐
9) Wear medication patches on your skin YES ☐ NO ☐
10) Have any implanted objects in your body YES ☐ NO ☐
Such as: Aneurysm clips YES ☐ NO ☐
Coils, filters or stents YES ☐ NO ☐
Neurostimulator, Bloestimulator or Defibrillator YES ☐ NO ☐
Shrapnel, Bullets in your head YES ☐ NO ☐
Drug infusion or Insulin Pump YES ☐ NO ☐
Penile Implant YES ☐ NO ☐

Patient Weight: _____ Patient Height: _____

Patient Signature _____

Technologist Signature _____ Date _____

Form # 8500-010
Stock # 050976

Creatinine or GFR Clearance YES ☐ NO ☐
Date:

Previous Surgery

Head – Brain	YES ☐	NO ☐	Date:
ENT	YES ☐	NO ☐	Date:
Eye	YES ☐	NO ☐	Date:
Other	YES ☐	NO ☐	Date:
Neck	YES ☐	NO ☐	Date:
Chest	YES ☐	NO ☐	Date:
Spine	YES ☐	NO ☐	Date:
Abdomen	YES ☐	NO ☐	Date:
Other	YES ☐	NO ☐	Date:

FOR RADIOLOGIST USE ONLY: (P1) (P2) (P3) (P4)
PROTOCOL:

Appointment Date: _____
Time: _____

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The radiology report

- Radiology report may be difficult to read
- It is often written using:
  - Medical jargon
  - Terminology outdated
  - Often describing normal results using abnormal terms

"Degenerative disc disease"

Stay 2014

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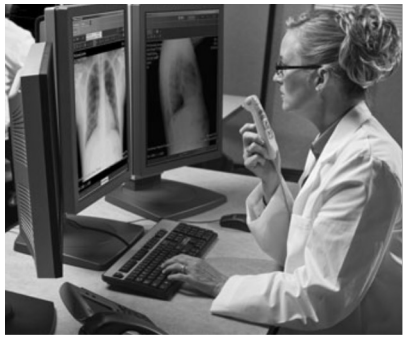
Anatomy of a report

Type of exams requested

- X-rays
- CT scan
- MRI
- Fluoroscopy
- PET
- Bone scan

Types of Views

- A-P
- Lateral
- Oblique
- Special view



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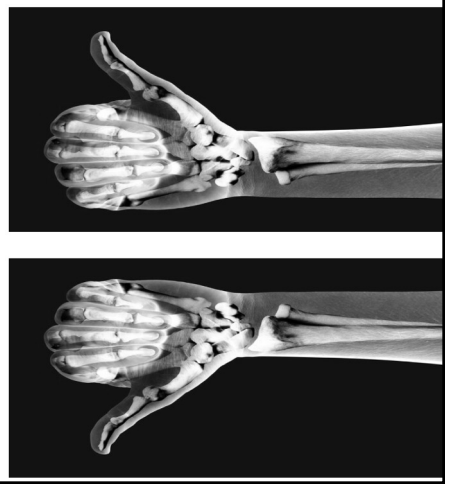
Anatomy of a report

Clinical information

- Were all relevant clinical findings communicated?
- Were all of these reviewed?
- Viewed by?
- Dictated by?



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Anatomy of a report

Comparison of previous imaging

- Have previous studies been reviewed for time-related changes:
  - Increased slip of spondylolisthesis
  - Increased curvature of scoliosis
  - Changes in bone density
  - Fracture healing

Stay 2014

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Anatomy of a report

Results:

Radiologists only dictate what they see

- "There is a young male standing with feet shoulder-width apart
- He wears a dark business jacket and a red tie
- The right hand and the right arm are held alongside the body
- The left hand holds an open red umbrella over the head
- The umbrella is held out of the center left of his body so that his right shoulder is not covered"

Nowhere does it say if it's raining or not

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Anatomy of a report

Impression

- We requested an X-ray because the diagnosis required clinical corroboration
- Everything that meets the clinical impression (if clearly indicated in the requisition) must be found here
- We are looking for a correlation of clinical and radiological results
- Other exams can be suggested

Stay 2014

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Imaging reports

The investigation report

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

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Imaging reports

FINDINGS

The undersurface of the acromion is flat indicating a type I configuration with no significant anterior or lateral downsloping of the acromion. No inferiorly directed osteophyte. The acromioclavicular joint demonstrates normal alignment. There is no elevation or fracture of the distal clavicle and no stress related changes or edema at the level of the AC joint.

There is mild tendinosis of the infraspinatus tendon with mild thickening and edema. There is scuffing/fraying and minimal partial-thickness articular-sided tearing involving the distal 2 cm of the infraspinatus tendon. There is no full-thickness tear of the rotator cuff. The supraspinatus, subscapularis and teres minor tendons are normal.

The cuff musculature is normal with no fatty atrophy or edema.

There is a linear pattern tear of the posterior superior labrum extending from approximately the 10 o clock to the 11 o clock position with minimal adjacent pericapsular edema along the posterior superior glenoid margin. The long head biceps anchor, intra- and extra-articular portions of the long head biceps tendon appear intact. The anterior and posterior inferior labrum appear normal.

The glenohumeral articular cartilage is well preserved. There is no occult fracture or malalignment. There is minimal subcortical enthesiopathic cystic change and marrow edema along the posterior aspect of the greater tuberosity. There is no osseous Bankart or Hill-Sachs lesion. The capsular structures of the glenohumeral joint appear normal with no capsular thickening. There is a trace amount of glenohumeral joint effusion, but no intraarticular body identified.

44

Imaging reports

[123 Main Street]
[Anywhere, Any province]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

Where was the imaging performed?

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

45

Imaging reports

[123 Main Street]
[Anywhere, Any province]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

Is this the correct patient?

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

46

Imaging reports

NationalRad Sample Musculoskeletal Report
[123 Main Street]
[Anywhere, Canada01234]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

Are you sure this the correct patient?

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

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Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

47

Imaging reports

NationalRad Sample Musculoskeletal Report
[123 Main Street]
[Anywhere, Canada01234]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

What type of examination was conducted?

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

48

Imaging reports

NationalRad Sample Musculoskeletal Report
[123 Main Street]
[Anywhere, Canada01234]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

Did the radiologist understand the reason for the referral?

49

Imaging reports

NationalRad Sample Musculoskeletal Report
[123 Main Street]
[Anywhere, Canada01234]
[Phone: 123.456.7890]
[Fax: 123.456.7890]

PATIENT: [JOHN SMITH]
DOB: [5/5/1955]
FILE #: [12345]
PHYSICIAN: [REFERRING]
EXAM: MRI OF THE RIGHT SHOULDER
CLINICAL INDICATION

The patient is a college pitcher. There is a history of pain and decreased velocity while pitching for the last 3 months.

TECHNIQUE

Multiplanar, multisequence MR imaging is performed through the right shoulder without contrast.

How was the examination was conducted?

50

Imaging reports

FINDINGS

- The undersurface of the acromion is flat indicating a type I configuration with no significant anterior or lateral downsloping of the acromion.
- The acromioclavicular joint demonstrates normal alignment.
- There is no elevation or fracture of the distal clavicle and no stress related changes or edema at the level of the AC joint.

How will this impact management?

51

Imaging reports

FINDINGS

- There is mild tendinosis of the infraspinatus tendon with mild thickening and edema. There is scuffing/fraying and minimal partial-thickness articular-sided tearing involving the distal 2 cm of the infraspinatus tendon.
- There is no full-thickness tear of the rotator cuff.
- The supraspinatus, subscapularis and teres minor tendons are normal.

How will this impact management?

.

52

Imaging reports

FINDINGS

- There is a linear pattern tear of the posterior superior labrum extending from approximately the 10 o'clock to the 11 o'clock position with minimal adjacent pericapsular edema along the posterior superior glenoid margin.
- The long head biceps anchor, intra- and extra-articular portions of the long head biceps tendon appear intact.
- The anterior and posterior inferior labrum appear normal.

How will this impact management?

53

Imaging reports

FINDINGS

- The glenohumeral articular cartilage is well preserved.
- There is no occult fracture or malalignment.
- There is minimal subcortical cystic change and marrow edema along the posterior aspect of the greater tuberosity.

How will this impact management?

54

Imaging reports

FINDINGS

- There is no osseous Bankart or Hill-Sachs lesion.
- The capsular structures of the glenohumeral joint appear normal with no capsular thickening.
- There is a trace amount of glenohumeral joint effusion, but no intraarticular body identified.

How will this impact management?

55

Imaging reports

IMPRESSION

- There is tendinosis and minimal partial-thickness articular-sided tearing involving the distal 2 cm of the infraspinatus tendon.
- There is a nondisplaced linear pattern tear of the posterosuperior labrum at approximately the 10 to 11 o'clock position.
- Given the history of pain and decreased velocity during pitching, the findings are compatible with internal impingement.

How will this impact management?

56

Imaging reports

IMPRESSION

- The osseous outlet and acromium and AC joint appear normal.
- The inferior glenoid labrum is normal with no Bankart lesion identified.
- The long head biceps tendon appears intact.

How will this impact management?

57

Imaging reports

Retrospective study of MRI findings and pitching performance

- 191 professional pitchers
- 52 individuals had partial-thickness tears
- (87%) were grade 1 in severity
- (12.8%) were grade 2 or higher.

Outcomes:

- The earned run average of the pitchers did not increase significantly immediately after damage or at post-damage years 1 and 2.
- Winning percentage increased significantly compared with pre-damage year 1

Jin-Young 2019

58

Communication

- Who do you communicate the results with?
- How do you communicate the results
- What further actions should be taken?
- Who will take these further actions?
- Who will be responsible for managing the case?

59

Documentation

Investigation order

The file should clearly outline:

- Risks, benefits and alternatives education
- The patient's consent
- The type of investigation ordered
- The clinical question
- The follow-up plan
- A copy of the requisition

60

Documentation

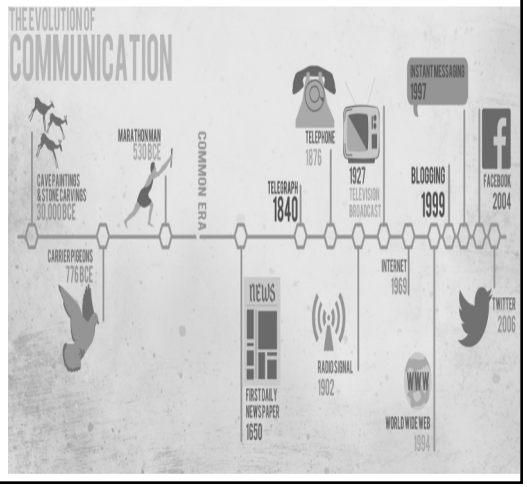
Investigation results

Depending on local practice, radiology reports may be :

- Sent by mail
- Faxed
- Transmitted electronically

To the health professional who requested it.

Cc to others specified on requisition



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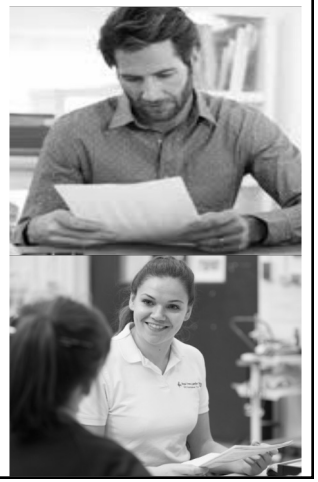
Documentation

Investigation results

- Read it in full
- Reflect on the findings and impressions mentioned in the report
- Follow-up with recommended further investigations
- Communicate results to the patient appropriately
- Communicate to all other health professionals as required
- Document all communication, findings and plan of care
- Maintain a copy of the report in the file



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Diagnostic Imaging Utilization

Unit 3

Errors in diagnostic testing

63

Errors in diagnostic testing

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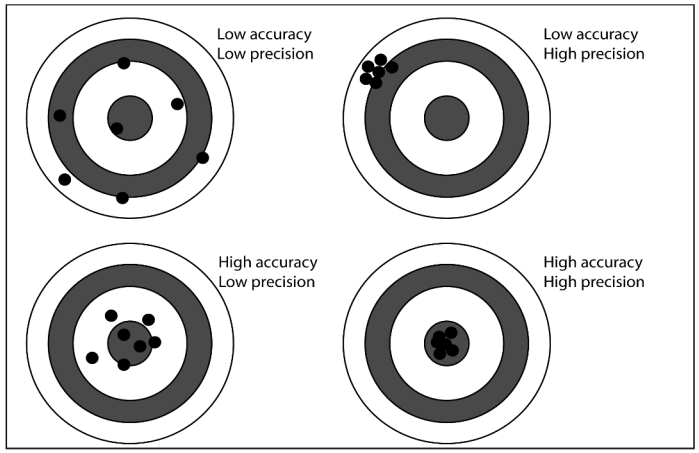
Errors in diagnostic testing



65

Errors in diagnostic testing

5 possible outcomes:

1. Positive for suspected diagnosis
2. Negative for suspected diagnosis
3. Negative for 1 diagnosis but raises suspicion of alternate
4. Wrong
5. Inconclusive requiring additional investigation

66

Errors in diagnostic testing

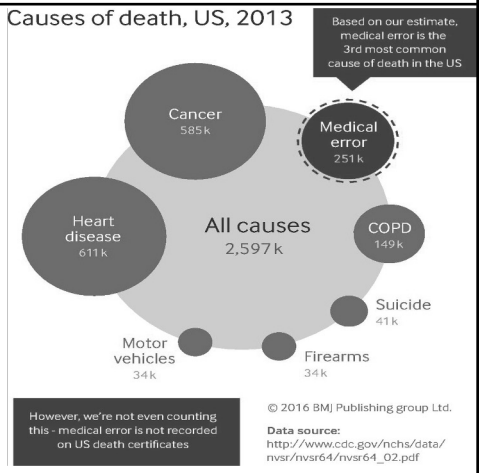
US annual medical error death rate:
- 250,000
- Third leading cause of death in the US

Larger than:
- Car accidents
- Breast cancers
- Work accidents

Estimated diagnostic error rate:
- 4-20%

Minimal global incidence:
- 40 million annually

Bruno 2015, Makary 2016, Jason 2018

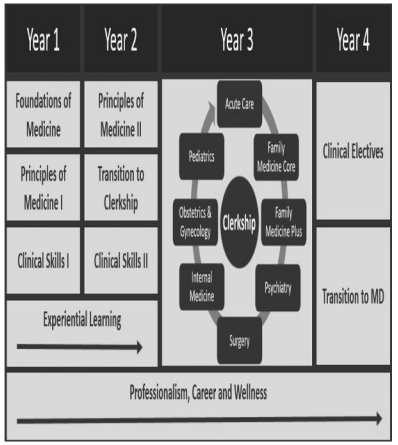


67

Errors in diagnostic testing

Survey of Canadian medical students
545 respondents from all 17 medical schools
- Didactic lectures were the most common encountered teaching method (74%)
- Self-guided studying (49%)
- Problem-based small groups (29%)
- No formal radiology education in school (12%)
- Radiology concepts tested in preclinical exams (79.1%)
- Did not feel they had adequate exposure to radiology during medical school (87%)

Rohren 2021, Western U 2023



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Errors in diagnostic testing

Potential points of error

1. Wrong investigation
2. Wrong patient
3. Wrong technique
4. Wrong reading
5. Wrong dictating
6. Wrong transcribing
7. Wrong transmission
8. Wrong reading
9. Wrong saying
10. Wrong understanding

69

Errors in ordering

Scoping review of imaging overutilization 370 studies

Spine, pelvis, hip imaging		
Type of imaging	**Reason for examination**	**Outcome**
L-spine XR, CT, MRI	Low back pain	Low rate in change of management MRI: 41.3% relevant findings
Post-op L or C-spine XR	Instrumented single-level degenerative spinal fusions	Does not change treatment of patient
Post-op L-spine XR	Lumbar fusion	0–1% relevant findings
Spine XR	Acute neck or back pain	0.4% relevant findings
Pelvic XR	Sever trauma	No change in management
CT/MRI pelvis	Pelvic ring fracture	No change in management
Routine Pelvic XR	Pelvic fracture	No change in management in patients with painless straight leg raise
	Trauma	10% change in management
Post-op Hip XR	Hip hemiarthroplasty	No change in management
	Hip fracture	No change in management
MRI Hip	Hip pain	After XR—low impact on treatment

Kjelle 2021

70

Errors in ordering

Scoping review of imaging overutilization 370 studies

Lower extremities		
Investigation	**Reason for examination**	**Outcome of results**
Knee pain	< 1% change in treatment	Use XR first MRI if locking or surgical history or conservative treatment fails
Post-op knee XR	Anterior cruciate ligament reconstruction	Do not change patient management
	Partial knee arthroplasty	No change in management
	Primary total knee replacement	Do not change patient management
	Medial patellofemoral ligament reconstruction	Do not change patient management
Knee/foot XR of adjacent joints	Ankle fracture	Do not change patient management
Ankle MRI	Acute Achilles Tendon Ruptures	Imaging generally not indicated in guidelines
Lower limb imaging	Lower extremity stress fractures	Low diagnostic accuracy of CT, XR, US
Post-op lower limb XR	Tibia plateau fixation	0.7% change in patient management
XR, CT, MRI, bone scans, FDG-PET	Musculoskeletal Tumors	Do not change patient management
Post splinting skeletal XR	Fractures	Do not change patient management
Post-op CT of joints	Peri-articular fractures	< 5% change in management
CT of joints	Orthopedic trauma (spine, pelvis, lower extremities)	25.3% relevant findings
Musculoskeletal MRI	Long bone cartilaginous lesions	Advanced imaging was used too often

Kjelle 2021

71

Errors in ordering

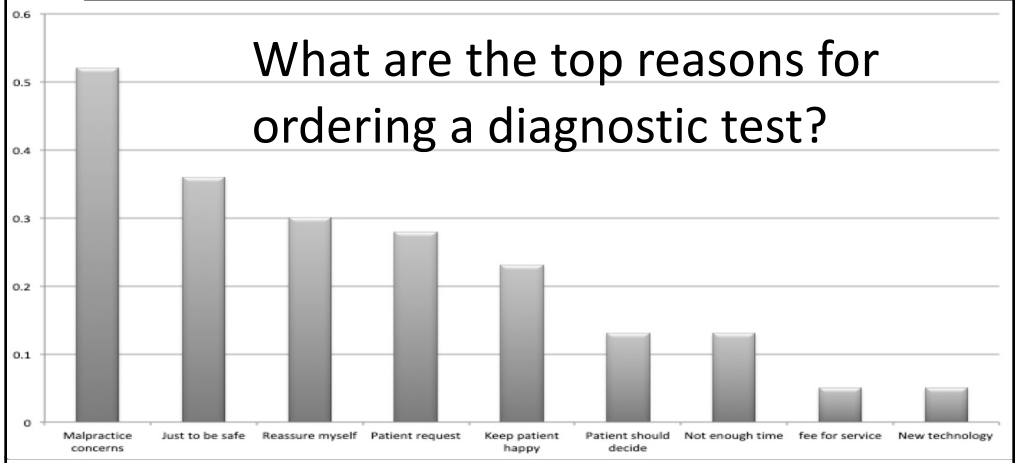
Scoping review of imaging overutilization 370 studies

Upper extremities		
Investigation	**Reason for examination**	**Outcome of results**
Shoulder MRI	Shoulder pain	20% relevant findings other imaging modalities could not find
	Rotator cuff tear	9.8% change in management
Routine shoulder XR	Frozen shoulder	2.3% relevant findings
	Atraumatic shoulder pain	14.9% change in diagnosis 1.7% change in management
Post-op shoulder XR	Primary anatomic total shoulder arthroplasty	0–5% relevant findings No change in management
Post-op humerus XR	Supracondylar humerus fracture	Do not change patient management
Wrist MRI	Wrist ligamentous injury	28% change in management
Follow-up wrist XR	Uncomplicated distal radius fracture	Do not change patient management
	Distal radius fracture Fixation with a Volar Locking Plate	0–4% change in patient management
	Distal radius fracture	Do not change patient management
Upper extremity MRI	Work related complaints	No change in management

Kjelle 2021

72

Errors in ordering



Kelle 2022

73

Errors in ordering

Systematic evidence synthesis

69 qualitative studies with 1747 participants

Patients and clinicians believe:

- Diagnostic imaging is an important test to locate the source of low back pain

Patients with chronic low back pain believe:

- Pathological findings on diagnostic imaging provide evidence that pain is real

Clinicians ordered diagnostic imaging to:

- Reduce the risk of a missed diagnosis
- Reduce the risk of litigation
- Manage patients' expectations

Sharma 2020

74

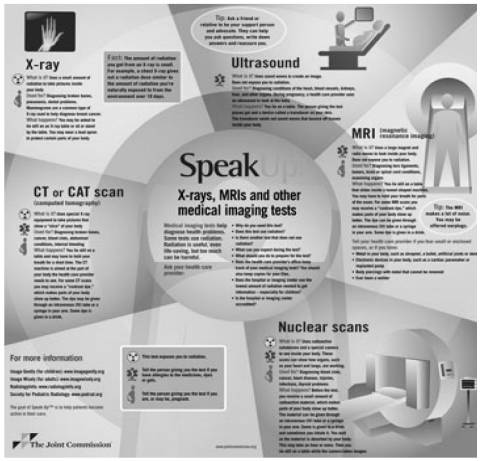
Errors in ordering

Australian campaign to reduce public's desire for imaging

Focus group reaction to information posters:

- Posters were alarming
- Concern about discouraging necessary care
- Negative reaction to use of fear
- Mistrust of the veracity & intent of the information
- Trust in doctor's advice over public health campaign

Sharma 2021



75

Errors in reading

76

Errors in reading

- The rate of missed, incorrect, or delayed diagnoses estimated to be as high as 10%–15%.
- Autopsy studies have identified major diagnostic discrepancies in up to 20% of cases, suggesting that the working or final clinical diagnosis may be wrong in as many as one in five patients overall
- **Average time to view an image: 2 seconds**

Berner 2008, McDonald 2015

77

Errors in reading

- The rate of missed, incorrect, or delayed diagnoses estimated to be as high as 10%–15%.
- Autopsy studies have identified major diagnostic discrepancies in up to 20% of cases, suggesting that the working or final clinical diagnosis may be wrong in as many as one in five patients overall
- **Average time to view an image: 2 seconds**

Berner 2008, McDonald 2015

What did you see?

78

Errors in reading

- The rate of missed, incorrect, or delayed diagnoses estimated to be as high as 10%–15%.
- Autopsy studies have identified major diagnostic discrepancies in up to 20% of cases, suggesting that the working or final clinical diagnosis may be wrong in as many as one in five patients overall
- **Average time to view an image: 2 seconds**

Berner 2008, McDonald 2015

Polydactyly

79

Errors in reading

Cause of error	Explanation	%
Underreading (missed finding)	A finding is present on the image but missed	42.0
Satisfaction of search	A finding is missed because of a failure to continue to search for additional abnormalities after a first abnormality was found	22.0
Faulty reasoning	A finding is appreciated and interpreted as abnormal but is attributed to the wrong cause (true positive but misclassified)	9.0
Location	A finding is missed because of the location of a lesion outside the area of interest on an image	7.0
Satisfaction of report	A finding was missed because of overreliance on the radiology report from a previous examination	6.0

Kim 2014

80

Errors in reading

Cause of error	Explanation	%
Poor examination	A finding is missed because of failure to consult prior to radiologic studies or reports	5.0
History	A finding is missed because of inaccurate or incomplete clinical history	2.0
Technique	A finding is missed because of the limitations of the examination or technique	2.0
Complacency	A finding is appreciated but attributed to the wrong cause (false-positive finding)	0.9
Complication	A complication from a procedure	0.5
Poor communication	An abnormality is identified and interpreted correctly but the message does not reach the clinician	0.5

Kim 2014

81

Errors in analysis

- Is the result correct for the patient?
- Does the result fit the clinical picture?
- Is the result within the expected population range?
- Is the abnormality of diagnostic significance?
- If one of a series of results has there been a change that is clinically significant?

Does it "fit"?

82

Errors in analysis

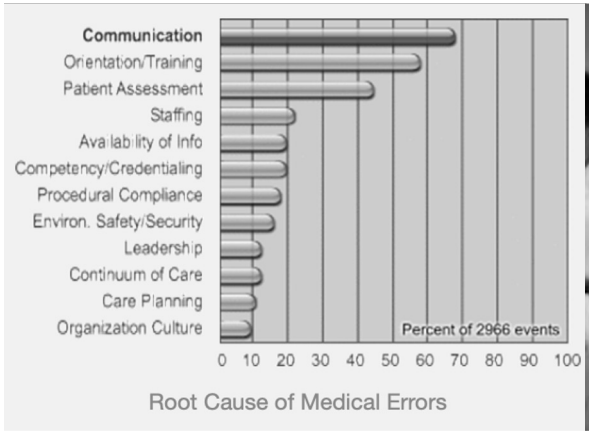
Findings in an asymptomatic population	Age (yrs)						
	20	30	40	50	60	70	80
Disc degeneration	37%	52%	68%	80%	88%	93%	96%
Disc signal loss	17%	33%	54%	73%	86%	94%	97%
Disc bulge	30%	49%	50%	60%	69%	77%	84%
Disc height loss	24%	34%	45%	56%	67%	76%	84%
Facet degeneration	4%	9%	18%	32%	50%	69%	83%
Disc protrusion	29%	31%	33%	36%	38%	40%	43%
Spondylolysthesis	3%	5%	8%	14%	23%	35%	50%

	Condition Present	Condition Absent
Test Positive	True Positive	False Positive
Test Negative	False Negative	True Negative

Brinikji 2015

83

Errors in communication



Troude 2014

84

Errors in communication

Position Statement from AAOMPT

"To discontinue the use of the term degenerative disc diseases and the inaccurate implication of a clinical relationship between age-related changes in the disc and patient symptoms"

AAOMPT 2019

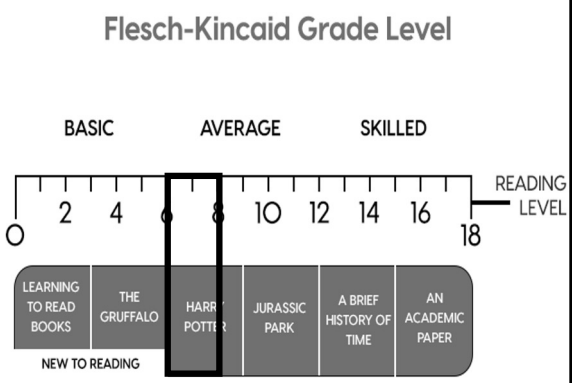
So let's start by call these "Normal Age Related Changes" (NARC)

85

Errors in communication

Average North American adult reading comprehension level?

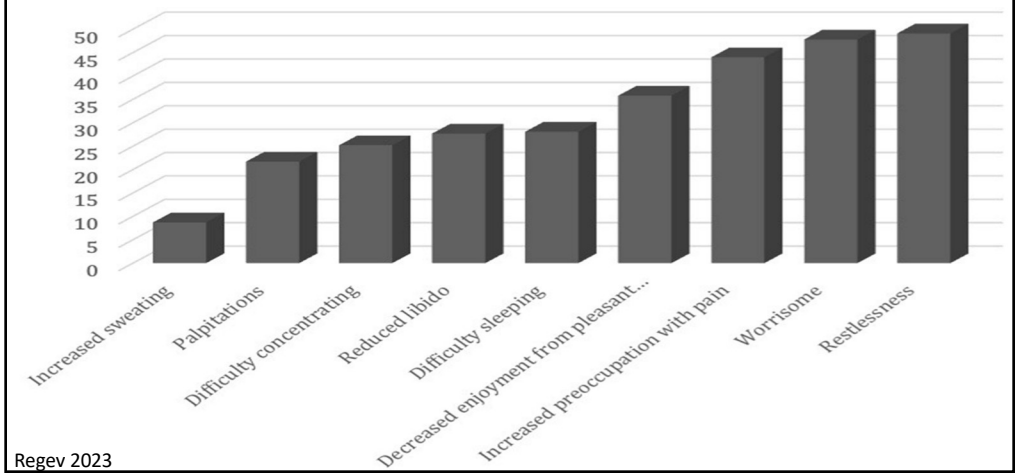
Grade 6 - 8



Wyllie 2023

86

Errors in communication



Regev 2023

87

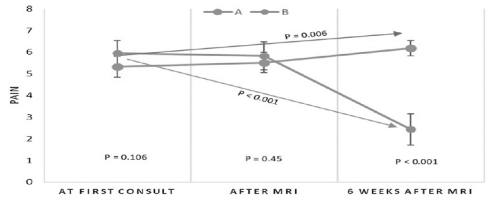
Errors in communication

Blinded randomized trial

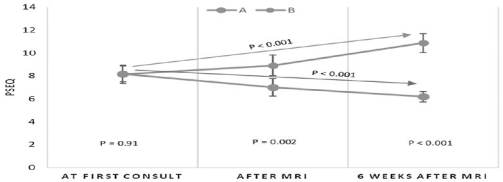
44 patients with LBP

- Group A: A factual explanation of their MRI report
- Group B: Reassured that the MRI findings showed normal changes.

Rajasekaran 2021



Patient's pain (VAS)



Patient's perception of pain (PSEQ-2)

88

Errors in communication

Blinded randomized trial

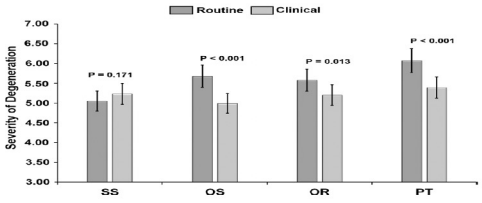
20 MRI reports read by:

- Spine surgeons
- Orthopaedic surgeons
- Orthopaedic residents
- Physiotherapists

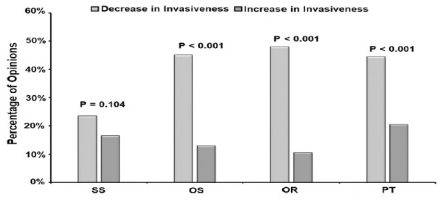
Round1: Reassured that the MRI findings showed normal changes

Round 2: Provided a factual MRI report

Rajasekaran 2021



Change in perception of degenerative pathology



Change in perception of need for intervention

89

Errors in management

RCT 422 pts with LBP

- Randomized to either L/S radiography or no radiography
- Patients who received L/S radiographs were more satisfied with care

BUT:

- No differences in outcome between the groups at 9 months

Miller 2009

90

Errors in management

- 380 pts with LBP whose MD ordered L/S imaging - randomized to either MRI or L/S radiography
- No differences between the groups at 12 months regarding outcome
- Episode of care $300 more for MRI group
- **MRI group had twice the amount of L/S surgeries**

Jarvak 2003

91

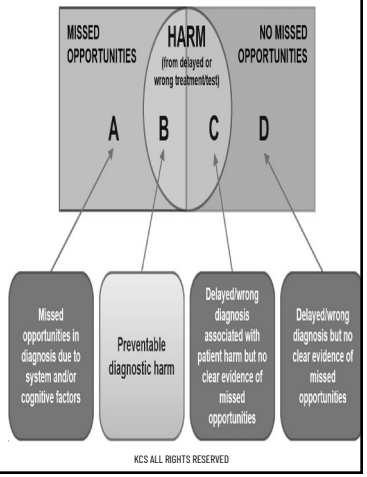
Errors in management

Estimated that up to 65% of clinically relevant findings found via diagnostic imaging are not managed appropriately by referring providers.

Barriers to effective management:

- Who is responsible when the radiologist recommends further testing
- The time and effort required to appropriately manage imaging results may often occur outside of dedicated patient care hours.
- How and when the communication of findings is handled with patients.
- Most patients would like to receive the results of their imaging studies as soon as possible, often within 24 hours.

Singh 2002, Sloan 2014, Keil 2021



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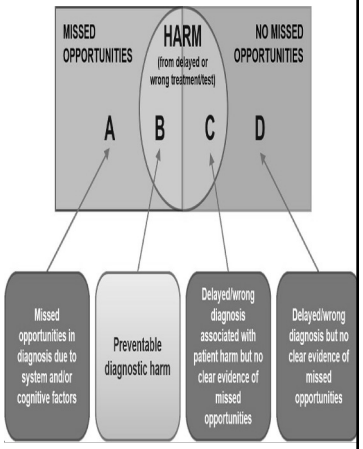
Errors in management (Cont.)

Barriers to effective management:

- If a patient is not scheduled for a follow-up visit with the referring physical therapist follow-ups may "get dropped"
- When adverse and clinically relevant findings are encountered on imaging, optimal communication should include both verbal and non-verbal signs of compassion followed by clear recommendations regarding clinical management.
- In the event that imaging reveals a condition that may fall outside our scope of practice (ie, a mass or growth), each practitioner must decide how best to communicate the results to their patient.

Singh 2002, Sloan 2014, Keil 2021



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Diagnostic investigation

Downstream consequences of inappropriate MRI of the lumbar spine

Retrospective study of 405,965 participants

Received:

1. MRI within 6 weeks of the primary care visit for low back pain

OR

2. Delayed (> 6 weeks of the primary care visit) or no imaging

Jacobs 2020

Intervention	Early MRI	Delayed MRI
Back surgery	1.48%	0.12%
Opioid use	35.1%	28.6%
Final pain scores	3.99%	3.87%
Care cost	$8082	$5560

94

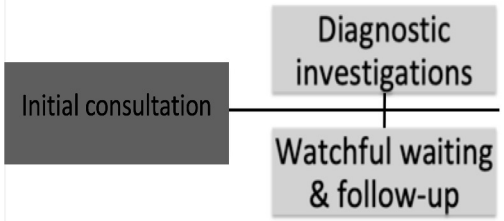
Watchful waiting

Red flag screening for low back pain: nothing to see here move along: a narrative review

Recommendations:

1. The importance of watchful waiting
2. Value-based care does not support clinical examination driven by red flag symptoms
3. The recognition that red flag symptoms may have a stronger relationship with prognosis than diagnosis

Devo 1988, Cook 2018



Common indicators of systemic pathology

- Failure with conservative care (usually over 4- 6 weeks)

95

Reducing errors

Diagnostic testing & findings

Must be placed in the appropriate clinical context with:

1. A detailed history
2. A thorough physical exam
3. **Sound clinical reasoning**

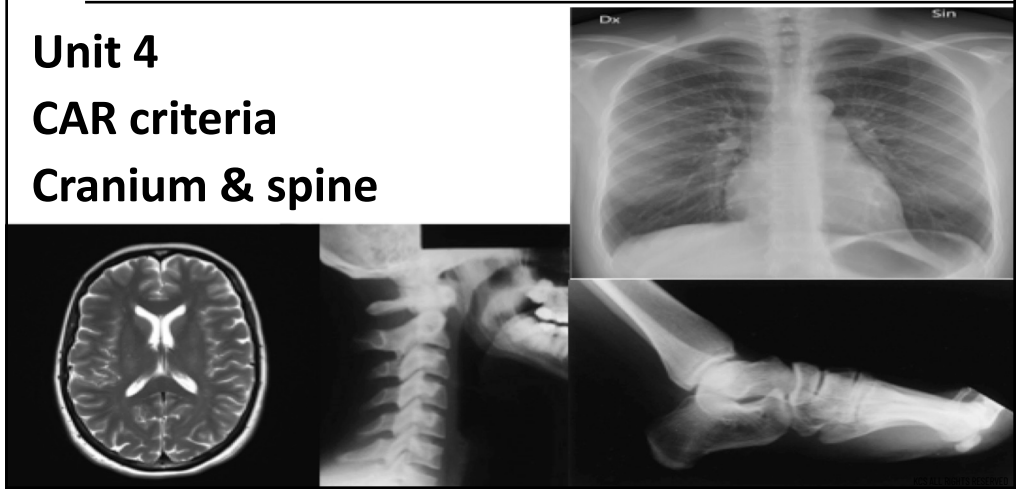
96

Diagnostic Imaging Utilization

Unit 4

CAR criteria

Cranium & spine



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CAR Diagnostic Imaging Referral Guidelines

Canadian Association of Radiologists

- A comprehensive set of evidence-based, peer reviewed referral guidelines to support clinical decision making by referring clinicians.
- The primary objective is to promote the most appropriate diagnostic imaging procedures so that patients receive these procedures at the right time resulting in better health outcomes

CAR web site:
https://car.ca

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CAR appropriateness guidelines

Cranium:
- 12 scenarios

Cervical spine
- 5 scenarios

Lumbar, thoracic, pelvis
- 13 scenarios

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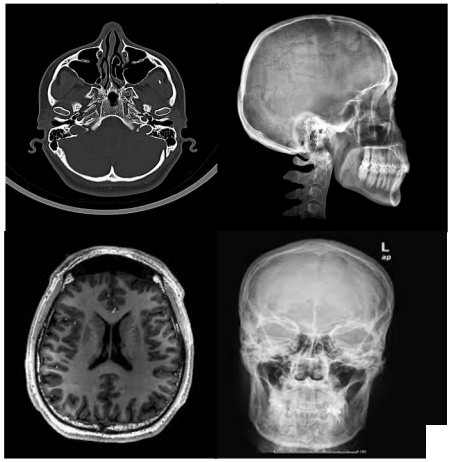
Cranium

1. Headache: chronic recurrent 1
2. Headache: chronic/recurrent 2
3. Headache: Low pressure
4. Orbital lesions: trauma
5. Temporomandibular joint dysfunction
6. Mandibular trauma
7. Head injury 1
8. Head injury 2
9. Blunt orbital trauma
10. Middle third face injury
11. Conscious patient with head or facial injury
12. Unconscious patient with head injury



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Headache: chronic/recurrent

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢ ☢	CT is an excellent modality to screen for significant intra-cranial pathology. In the absence of focal features imaging is not often helpful. The following features significantly increase the likelihood of finding major abnormality and justify requesting diagnostic imaging: • Recent onset and rapid increasing frequency and severity of headache • Headache causing the patient to wake from sleep • Associated dizziness, lack of coordination, tingling or numbness, new neurological deficit • New onset of a headache in a patient with a history of cancer or immunodeficiency If imaging is indicated, CT can be used, however radiation is a consideration for repeat examination

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Headache: chronic/recurrent

Investigation	Recommendation	Radiation	Comments
MRI	Indicated in specific circumstances	○	In the absence of focal features, imaging is not often helpful. The following features significantly increase the likelihood of finding major abnormality and justify requesting diagnostic imaging: • Recent onset and rapid increasing frequency and severity of headache • Headache causing the patient to wake from sleep • Associated dizziness, lack of coordination, tingling or numbness, new neurological deficit • New onset of a headache in a patient with a history of cancer or immunodeficiency

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Headache: Low pressure

Investigation	Recommendation	Radiation	Comments
MRI	Specialized investigation	○	In the presence of intermittent headache happening when upright and disappearing while recumbent, MRI is the best investigation. If there is a clinical indication for determining the site for a CSF leak, cisternography can be performed using MRI, CT or nuclear medicine.
CT	Specialized investigation	☢☢	When MRI is not available or contra-indicated, CT can be used.

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Orbital lesions: trauma

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢☢	CT is indicated when an orbital fracture is suspected

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Temporomandibular joint dysfunction

Investigation	Recommendation	Radiation	Comments
MRI	Specialized investigation	◯	MRI is the best imaging modality to show internal derangement of the temporomandibular joint but it should only be ordered by a specialist or after consultation with a radiologist
XR	Not indicated	☢	XR is not usually helpful because it shows only late bony changes not the internal derangement which causes most of the symptoms.

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Mandibular trauma

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢ ☢	CT should be performed where available for superior fracture detection
XR (mandible)	Indicated	☢	Panoramic XR is not appropriate in uncooperative or multiply injured patients. CT should be performed when available

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Head injury

Investigation	Recommendation	Radiation	Comments
XR (skull)	Not indicated	☢	There is poor correlation between the presence of a skull fracture and a clinically significant head injury. The only indications for a skull XR in the setting of trauma are suspected open or depressed skull fractures, If CT is not available and suspected child abuse.
CT	Indicated	☢ ☢	CT is indicated in all patients with a severe head injury (GCS <13). In patients with minor head injury (GCS 13-15) and witnessed loss of consciousness or disorientation or definite amnesia CT is indicated to rule out a head injury requiring neurosurgical intervention if there is: • GCS < 15 >2 hours after the injury • Suspected open or depressed skull fracture • Any sign of a basal skull fracture • Two or more episodes of vomiting • Age > 65 years To rule out any other clinically significant intracranial injury the following additional risk factors justify obtaining CT: • Amnesia for before the impact lasting > 30 minutes • Dangerous mechanism of injury (MVC, fall > 1 m. or > 4 stairs)

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Head injury

Investigation	Recommendation	Radiation	Comments
CT (angio-graphy)	Specialized investigation	☢ ☢	CT angiography should be performed with presentation of high energy transfer mechanism or if associated with any of the following: • Displaced mid-face fracture • Basilar skull fractures with carotid canal involvement • Focal neurological deficit • Fracture at C1-3 • Clothesline type injury or seat belt abrasion with significant swelling/pain • Altered mental status

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Blunt orbital trauma

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢☢	CT is indicated when an orbital fracture of globe injury is suspected
XR (orbits)	Indicated	☢	May be used if CT is not available

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Middle third face injury

Investigation	Recommendation	Radiation	Comments
CT (facial bones)	Indicated	☢☢	Patient cooperation is essential to obtain views of diagnostic quality. Consider delay if patient is uncooperative. Should be considered in setting of abnormal XR, suspected fracture, foreign body, hematoma or diploplia
XR (facial bones)	Indicated	☢	Discuss with maxillo-facial surgeon who may request low dose CT at an early stage in management of complicated cases. Although plain XRs have had a historical role, CT is the imaging modality of choice.

110

Conscious patient with head or facial injury

Investigation	Recommendation	Radiation	Comments
XR (Cx)	Indicated only in specific circumstances	☢	In alert, stable patient XR is indicated only if there are the following risk factors: • Age > 65 • Dangerous mechanism of injury • Paresthesias in the extremities or other neurological deficit • Midline spine tenderness • Inability to actively rotate the neck 45° right and left (Canadian C-spine rules)
CT (Cx)	Indicated	☢☢	CT should be obtained as a first line modality if available and to further characterise injury seen on XR

111

Unconscious patient with head injury

Investigation	Recommendation	Radiation	Comments
CT (Cx)	Indicated	☢☢	CT is indicated to characterize both bony and soft tissue injury.
XR (Cx)	Indicated in specific circumstances	☢	Indicated only if CT is not available

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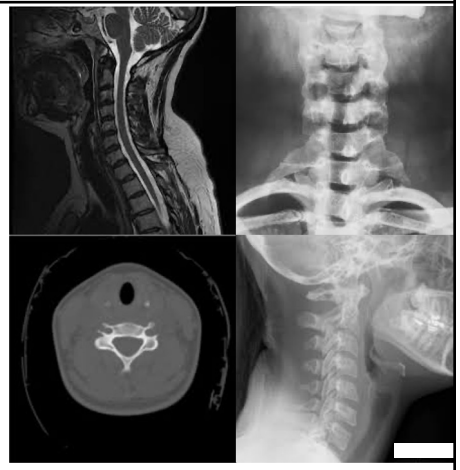
Cervical spine

1. Neck mass of unknown origin
2. Myelopathy
3. Suspected discitis
4. Possible atlanto-axial instability
5. Neck pain, brachialgia, degenerative change



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Neck mass of unknown origin

Investigation	Recommendation	Radiation	Comments
US	Indicated	◯	US is the best imaging for assessing a neck mass
CT	Indicated only in specific circumstances	☢ ☢	CT could be used to determine the full extent of large lesions not fully visualized by US
MRI	Indicated only in specific circumstances	◯	MRI could be used to determine the full extent of large lesions not fully visualized by US

114

Myelopathy

Investigation	Recommendation	Radiation	Comments
MRI	Indicated	○	MRI is the best imaging modality for evaluating suspected spinal cord lesions and possible cord compression
CT	Specialized investigation	☢ ☢	CT is usually indicated only if better bony detail is required.
CT Myelo-graphy	Specialized investigation	☢ ☢	CT myelography may be required if MRI is contraindicated or a diagnostic dilemma remains after CT or MRI

115

Suspected discitis

Investigation	Recommendation	Radiation	Comments
MRI	Indicated	○	MRI is the best imaging modality for evaluating suspected discitis or osteomyelitis
CT	Specialized investigation	☢ ☢	CT is usually indicated only if better bony detail is required.
NM	Indicated only in specific circumstances	☢ ☢	If MRI is contraindicated or the findings equivocal, a combined bone and gallium scintigraphy is helpful. The combination of bone and gallium scanning is more specific than MRI especially in the postoperative or post instrumentation setting. It can also be used to assess the presence of residual infection after therapy.

116

Possible atlanto-axial instability

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	Lateral cervical spine XRs in flexion and extension are the appropriate imaging to assess possible cervical spine instability with rheumatoid arthritis, Down's syndrome etc.
MRI	Specialized investigation	○	MRI is valuable to show damage secondary to chronic atlanto-axial instability

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Neck pain, brachialgia, degenerative change

Investigation	Recommendation	Radiation	Comments
MRI	Indicated	○	Imaging is only indicated when there are neurological signs or symptoms or if pain persists after conservative management for mor than four weeks.
CT	Indicated only in specific circumstances	☢ ☢	CT is indicated when MRI is contraindicated or unavailable
XR	Not indicated	☢	Degenerative changes begin to appear on XR in early middle age and are usually unrelated to the patient's symptoms.

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Neck injury & pain without neurological deficit

	Recommendation	Radiation	Comments
CT(Cx)	Indicated	☢ ☢	CT is indicated to characterized both bony & soft-tissue injury.
MRI	Specialized investigation	◯	May be valuable in specialized situations where CT is negative and a purely ligamentous injury is suspected, or to further characterize injury already seen on CT
XR (Cx)	Indicated	☢	Indicated only if CT not readily available

119

Neck injury with pain but XR normal: suspected ligamentous injury

Investigation	Recommendation	Radiation	Comments
CT (Cx)	Indicated	☢ ☢	CT should be performed to detect radiographically occult fracture
MRI	Specialized investigation	◯	MRI demonstrates ligamentous injuries better than CT
XR (Cx)	Specialized investigation	1 ☢	Views taken in flexion and extension (consider fluoroscopy) as achieved by the patient with no assistance and under medical supervision

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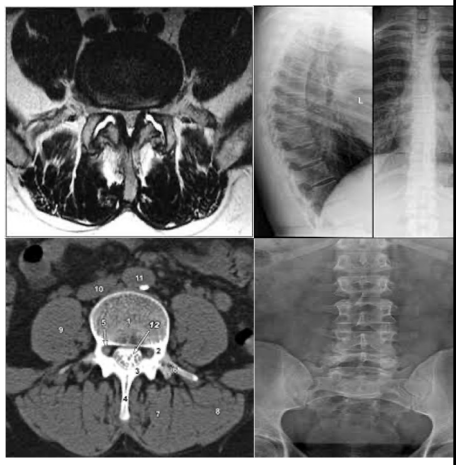
Lumbar, thoracic, SI, Pelvis

1. Trauma without neurological deficit with or without pain
2. Trauma with neurological deficit with or without pain
3. Thoracic pain without trauma
4. Chest trauma: Minor, suspected rib fracture
5. Minor chest trauma
6. Major chest trauma
7. Trauma with neurological deficit with or without pain
8. Osteoporotic vertebral compression fractures with pain
9. Lower back pain 1
10. Lower back pain 2
11. Lower back pain 3
12. Sacroiliac pain
13. Fall with pain



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Trauma without neurological deficit with or without pain

Investigation	Recommendation	Radiation	Comments
XR (Lx)	Indicated in specific circumstances	☢	Imaging is not usually indicated in a conscious asymptomatic patient, who can be reliably examined. Imaging is indicated if there is a history of a significant mechanism such as a fall or a high-impact MVC, if there is pain and/or tenderness or if the patient cannot be reliably evaluated. XR may also be indicated in situation when CT is not readily available
CT (Lx)	Indicated	☢ ☢	Threshold to CT should be low when there is pain/tenderness, a significant mechanism of injury, the presence of other spinal fractures, or when it is not possible to clinically evaluate a patient

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Trauma with neurological deficit with or without pain

Investigation	Recommendation	Radiation	Comments
CT (Lx)	Indicated	☢☢	CT is indicated to further evaluate for injury with or without localizing signs
MRI(Lx)	Indicated	○	MRI is indicated if there is concern about a cord injury not seen on CT, if a purely ligamentous injury is suspected or to further characterize injury already seen on CT
XR (Lx)	Indicated	☢	Should be performed only when CT unavailable

123

Thoracic pain without trauma

Investigation	Recommendation	Radiation	Comments
XR(Thx)	Indicated only in specific circumstances	☢	XR may be used if a compression fracture or a metastasis is suspected. However, it does not distinguish between an acute and an old fracture and it is not as sensitive as MRI for metastasis.
Nuc Med bone scan with SPECT (Thx)	Indicated only in specific circumstances	☢	When malignancy is suspected or known, in osteoporotic patients especially to determine age of compression fractures, to aid in selection of vertebral levels for vertebroplasty, to evaluate patients in whom other investigations of the Thx-spine are negative (assessment of chest wall, ribs etc.)
MRI (Thx)	Indicated only in specific circumstances	○	If there is clinical concern about an epidural abscess or hematoma which may be present with acute pain but no neurological symptoms, urgent MRI is required. Imaging is otherwise only indicated when there are neurological symptoms, or if pain persists after conservative management for more than four weeks.
CT (Thx)	Indicated only in specific circumstances	☢☢	CT is indicated only if MRI is contraindicated or not available or if more bony detail is necessary.

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Chest trauma: Minor, suspected rib fracture

Investigation	Recommendation	Radiation	Comments
XR (Cx)	Indicated in specific circumstances		Undisplaced rib fractures are difficult to identify and their diagnosis does not alter management. However, identification of rib fractures may be useful in order to counsel patients on recovery.

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Minor chest trauma

Investigation	Recommendation	Radiation	Comments
XR (Cx)	Indicated only in specific circumstances		Suspected rib fractures, to rule out pneumonia, hemothorax or lung contusion
XR (Ribs)	Not indicated		XR is not sensitive for rib fractures and therapy is pain management with or without a demonstrated fracture
CT	Not indicated		

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Chest trauma: Moderate to severe

Investigation	Recommendation	Radiation	Comments
XR (Chest)	Indicated in specific circumstances	☢	Chest XR is indicated as an initial examination but should not delay CT if there are suspected severe injuries such as a pneumothorax
CT (Chest)	Indicated	☢☢	CT with contrast is indicated in the setting of severe trauma or penetrating injury in a patient who is hemodynamically stable. Unstable patients may require immediate surgery.
CT Angio graphy (Chest)	Indicated in special circumstances	☢☢	CTA is indicated in the setting of suspected traumatic aortic injury, or high energy transfer mechanism

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Chest trauma: Major

Investigation	Recommendation	Radiation	Comments
XR (Cx)	Indicated	☢	To exclude pathology that threatens immediate hemodynamic stability
CT	Indicated	☢☢☢	CT is much more sensitive than RX (Cx) for evaluation of great vessel injury, flail chest and diaphragmatic rupture.

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Trauma with neurological deficit with or without pain

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢☢	CT is indicated to further evaluate for injury with or without localizing signs
MRI	Indicated	○	MRI is indicated if there is concern about a cord injury not seen on CT, if a purely ligamentous injury is suspected, or to further characterize injury already seen on CT
XR	Indicated	☢	Should be performed only when CT is unavailable. Regardless CT/MRI is essential

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Osteoporotic vertebral compression fractures with pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢☢	Indicated to demonstrate compression fractures but cannot always distinguish acute from old fractures
NM	Specialized investigation	☢☢	NM is useful in distinguishing between recent and old fractures and can help exclude pathological fractures
MRI	Specialized investigation	○	MRI is the best imaging modality for distinguishing between acute and chronic osteoporotic collapse. It is also the best modality for distinguishing between osteoporotic and malignant vertebral collapse.

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Lower back pain

Investigation	Recommendation	Radiation	Comments
MRI (Lx)	Indicated in special circumstances	○	If imaging is indicated, MRI is the best modality. Imaging is only indicated if there are "red flag" indications: • Suspected cancer • Suspected infection • Cauda equina syndrome • Severe/progressive neurological deficit • Suspected compression fracture In patients with suspected uncomplicated disc or spinal stenosis imaging is **only indicated after an unsuccessful 4-6 week trial of conservative management**

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Lower back pain

Investigation	Recommendation	Radiation	Comments
CT	Indicated in special circumstances	☢ ☢ ☢	If imaging is indicated, MRI is the best modality. Imaging is only indicated if there are "red flag" indications: • Suspected cancer • Suspected infection • Cauda equina syndrome • Severe/progressive neurological deficit • Suspected compression fracture CT is only indicated if MRI is contraindicated or unavailable. CT can provide excellent imaging. In very large patients image noise can be a problem. The radiation dose is also a consideration

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Lower back pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated in special circumstances	☢	XR may be used if a compression fracture or a metastasis is suspected. However it does not distinguish between an old and new fracture and it is not as sensitive as MRI for metastasis.
NM	Indicated in specific circumstances	☢	When malignancy is suspected or known, in osteoporotic patients especially to determine the age of compression fractures, to aid in selection of vertebral levels for vertebroplasty or to evaluate patients in whom other investigations of the L-spine are negative

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Sacroiliac pain

Investigation	Recommendation	Radiation	Comments
XR (SI)	Indicated	☢	XR is usually the first initial imaging modality for the assessment of sacroiliitis in patients with seronegative arthropathy
MRI (SI)	Specialized investigation	○	MRI is the imaging modality of choice when strong suspicion of early sacroiliitis exists and the XR is normal
CT (SI)	Specialized investigation	☢☢☢	MRI is more sensitive than CT for early sacroiliitis, but CT may suffice if MRI is not not readily available
NM (SI)	Specialized investigation	☢☢	MRI is preferred over NM for early sacroiliitis, but NM may suffice if MRI is not readily available

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Fall with pain

Investigation	Recommendation	Radiation	Comments
XR (Pelvis and lateral hip)	Indicated	☢	XR is indicated as an initial imaging modality if a pelvic or femoral neck fracture is suspected.
CT (Pelvis and lateral hip)	Indicated	☢☢	CT is indicated if XR shows no fracture but there is ongoing pain or inability to weight bear. CT may also be indicated to further characterize fractures seen on CT
NM (Pelvis and lateral hip)	Indicated in specific circumstances	☢☢	NM bone scan should be performed at least 48-72 hours post-injury to maximize sensitivity

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Diagnostic Imaging Utilization

Unit 5

CAR criteria

Extremities & Pediatrics

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CAR Diagnostic Imaging Referral Guidelines

Canadian Association of Radiologists

- A comprehensive set of evidence-based, peer reviewed referral guidelines to support clinical decision making by referring clinicians.
- The primary objective is to promote the most appropriate diagnostic imaging procedures so that patients receive these procedures at the right time resulting in better health outcomes

CAR web site:
https://car.ca

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CAR appropriateness criteria

Medical pathologies
- 7 scenarios

Lower extremities
- 11 scenarios

Upper extremities
- 5 scenarios

Pediatrics
- 13 scenarios

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Medical pathologies

1. Osteomyelitis
2. Primary bone tumor
3. Soft tissue mass or tumor
4. Bone pain
5. Myeloma
6. Metabolic bone disease
7. Osteomalacia

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Osteomyelitis

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is indicated for initial imaging
MRI	Indicated	○	MRI is an excellent modality to assess osteomyelitis and associated soft tissue abnormalities especially in the spine
NM	Indicated	☢☢	Bone scan is useful after a normal or equivocal x-ray if osteomyelitis is suspected as a normal bone scan makes osteomyelitis very unlikely. If osteomyelitis is suspected but there are no localizing signs or symptoms, skeletal scintigraphy is useful, however findings are not specific.
CT	Specialized investigation	☢☢	CT is useful to guide soft tissue and bone biopsy and is the best imaging modality to evaluate for sequestra in chronic osteomyelitis
US	Specialized investigation	○	US may be helpful to assess for a sub-pereosteal abscess in acute osteomyelitis

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Primary bone tumor

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR should be performed when there is bone pain that is not resolving and it may be the only imaging required for some benign bone lesions
MRI	Specialized investigation	○	If the XR appearances are suggestive of a malignant bone tumor, referral to a specialist centre should not be delayed. MRI is the best imaging modality for local staging.
NM	Indicated	☢☢	If the XR appearances are suggestive of a primary bone tumor, obtaining skeletal scintigraphy should not delay referral to a specialist centre. NM is primarily used for evaluating the skeleton for additional sites of involvement. In most circumstances a normal excludes malignancy.
CT	Specialized investigation	☢☢	CT may be useful in some tumors such as osteoid osteoma and can demonstrate intra-tumoral calcification and ossification better than MRI

141

Known primary tumor, skeletal metastases

Investigation	Recommendation	Radiation	Comments
NM	Indicated	☢☢	Bone scintigraphy is useful for assessing the prevalence and extent of skeletal metastases in patients with know primary cancers. Its sensitivity and specificity is increased by using SPECT. It is more sensitive for osteoblastic metastases and relatively insensitive in assessing the extent of multiple myeloma. May be used to monitor the response to treatment
MRI	Indicated	○	MRI is useful to assess & characterize skeletal metastases particularly in the axial skeleton. Its sensitivity is lower for small osteoblastic metastases
XR	Not indicated	☢	XRs are only useful in the assessment of focal symptomatic sites or for correlation with NM findings

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Soft tissue mass or tumor

Investigation	Recommendation	Radiation	Comments
MRI	Indicated	○	MRI is the best imaging for evaluating soft tissue masses and in some cases provide a specific diagnosis
US	Indicated	○	US is useful for distinguishing between solid and cystic masses. It can be used to determine appropriate evolution of a presumed hematomas or follow other probably benign tumors.
XR	Indicated in specific circumstances	☢	XR can identify calcified and sometimes fatty tumor matrix and underlying osseous abnormalities.

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Bone pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is an important first step in evaluation of focal bone pain
NM	Indicated	☢☢	Indicated if pain persists within normal XR or equivocal and abnormal XR. Bone scans are commonly positive in patients with persistent bone pain and may be useful in directing more specific studies
MRI	Specialized investigation	○	MRI is an appropriate imaging modality if pain persists and XR and NM are normal. MRI may also provide further information when and/or NM findings are abnormal
CT	Specialized investigation	☢☢	CT can assist in further characterization of bony abnormalities identified on XR, NM, MRI.

144

Myeloma

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢☢	XR indicated for initial staging and planning for possible radiation therapy. Follow up of abnormalities can be limited to specific sites.
MRI	Specialized investigation	○	MR screening examination of the axial skeleton is very sensitive and particularly useful in patients with diffuse osteopenia or known non-secretory myeloma. It may be used for evaluation of a focal mass or follow up of disease extent.
NM	Not indicated	☢☢	NM has limited sensitivity and may mot detect sites of involvement

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Metabolic bone disease

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢☢	XR is the best imaging modality for identifying the characteristic features of some metabolic bone diseases such as hyperthyroidism and osteomalacia. It may also identify new vertebral compression fractures in patients with osteoporosis. Correlation with NM may be required
DEXA	Indicated	☢	DEXA is the standard technique to determine bone density. Quantitative CT may also accurately measure bone density.
NM	Indicated	☢☢	NM can help determine some causes of hypercalcemia (eg. hyperparathyroidism) and of raised alkaline phosphate (eg. Paget's disease). Bone scans can also differentiate new from old vertebral fractures.

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Osteomalacia with pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is the best initial imaging modality to establish a cause of local pain or to assess an equivocal lesion on NM
NM	Specialized investigation	☢☢	NM may demonstrate abnormal increased activity and associated complications (eg. pseudo-fractures)
MRI	Specialized investigation	○	MR may be used to establish the cause of local bone pain not shown on XR or to assess equivocal XR findings. May also be used in evaluation of complications, dating of fractures and identification of occult fractures if XRs are negative

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Lower extremities

1. Arthropathy
2. Arthropathy follow up
3. Non traumatic hip pain
4. Suspected avascular necrosis
5. Knee trauma: blunt trauma
6. Post-traumatic knee pain
7. Acute ankle injury
8. Acute foot injury
9. Stress fracture
10. Chronic foot pain
11. Painful surgical prosthesis

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Arthropathy

Investigation	Recommendation	Radiation	Comments
XR affected joint	Indicated	☢	XR may be helpful to determine the type of arthritis although visible bony changes are often a relatively late feature
XR hands/ feet	Indicated	☢	In patients with suspected rheumatoid arthritis, XR of the feet may show erosions in asymptomatic as well as symptomatic feet, even when symptomatic hands appear normal.
XR multiple joints	Indicated only in specific circumstances	☢☢	Only symptomatic joints should be x-rayed unless otherwise indicated by other clinical investigations
MRI	Specialized investigation	○	MRI can show acute synovitis, articular cartilage damage, early erosions and bone marrow better than XR
US	Specialized investigation	○	US may show acute synovitis and erosions in superficial joints.

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Arthropathy follow up

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is the investigation of choice
MRI	Indicated only in specific circumstances	○	MRI may be used by a specialist to assist management decisions
US	Indicated only in specific circumstances	○	US may be used by a specialist to assist management decisions

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Non-traumatic hip pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is indicated as the initial modality for persistent pain.
MRI	Specialized investigation	○	MRI is the best modality for further evaluation of persistent hip pain if the XR in normal. MRI arthrography is indicated for suspected labral tears.
NM	Indicated only for specific circumstances	☢☢	MRI is preferred over NM since NM is less specific, but NM may suffice if MRI is not readily available. May be a screening tool before MRI, especially in older patients (osteoporotic fractures). It should be noted that SPECT should be used.

151

Suspected avascular necrosis

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is indicated as the initial imaging modality, but it only becomes abnormal in established disease and may be negative within the first 6-9 months.
MRI	Indicated	○	MRI is the most sensitive imaging modality for the detection of early avascular necrosis and will show the extent of necrosis. MRI is useful to detect occult avascular necrosis in the contralateral hip.
NM	Specialized investigation	☢☢	NM can be used if MRI is not readily available
CT	Specialized investigation	☢☢	CT is not sensitive but may be used if MRI is not readily available

152

Knee trauma: blunt trauma

Investigation	Recommendation	Radiation	Comments
XR	Indicated in specific circumstances	☢	XR is the appropriate initial imaging modality. It is indicated if any of the following risk factors are present: • Age > 55 years • Tenderness over the head of the fibula • Isolated tenderness of the patella • Inability to flex to 90° • Inability to weight bear 4 steps immediately and in the ED (Ottawa knee rules)

153

Post-traumatic knee pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated only in specific circumstances	☢	Symptoms frequently arise form soft tissues which will not show on XR and osteoarthritic changes are common. XR is indicated in the following circumstances: • Sudden or onset or exacerbation of pain persisting more than 6 weeks in children and young adults • Suspected intra-articular bodies (XR will only identify radio-opaque intra-articular bodies) • Pre-operative evaluation for knee replacement
MRI	Indicated only in specific circumstances	○	MRI is the best imaging modality for the assessment of internal knee derangement (eg. Meniscal tears, intra-articular bodies)

154

Post-traumatic knee pain

Investigation	Recommendation	Radiation	Comments
US	Indicated only in specific circumstances	○	MRI is generally preferred over US because it evaluates the entire knee and it is not operator-dependent, however US may suffice if MRI is not readily available. US is indicated if the patient has anterior knee pain with suspected tendon pathology and/or bursitis.
NM	Indicated only in specific circumstances	☢ ☢	NM can be useful in identifying referred pain, stress fractures and other bony lesions.

155

Acute ankle injury

Investigation	Recommendation	Radiation	Comments
XR	Indicated in specific circumstances	☢	XR is the appropriate initial imaging modality. It is indicated if any of the following risk factors are present: • Inability to weight-bear four steps immediately or int the ED • Point tenderness over: • The medial malleolus and/or • The posterior edge and distal tip of the lateral malleolus. (Ottawa ankle rules)

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Acute ankle injury

Investigation	Recommendation	Radiation	Comments
CT	Indicated in specific circumstances	☢☢	CT is indicated to rule out an occult fracture if there is: • An ankle effusion in the setting of normal XR and combined effusion (anterior to posterior of greater than 13mm with ongoing suspicion of fracture, ongoing pain or inability to weight bear
MRI	Indicated in specific circumstances	○	MRI is indicated if there is a suspected isolated soft-tissue injury, occult fracture not seen on CT, or to further characterize fractures seen on CT

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Foot injury

Investigation	Recommendation	Radiation	Comments
XR	Indicated only in specific circumstances	☢	XR is the appropriate initial imaging modality. It is indicated if any of the following risk factors are present: • Bony tenderness along distal 6 cm of posterior edge of fibula or tip of lateral malleolus • Bony tenderness along distal 6 cm of posterior edge of tibia/tip of medial malleolus • Bony tenderness at the base of 5th metatarsal • Bony tenderness at the navicular • Inability to bear weight both immediately after injury and for 4 steps during initial evaluation (Ottawa ankle/foot rules)

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Stress fracture

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	This is the preferred initial imaging modality
CT	Indicated	☢☢	CT is indicated if there are ongoing symptoms and a negative XR
MRI	Indicted	○	MRI is the superior modality for detecting early un-displaced stress fractures which may be occult on CT and XR
NM	Indicated	☢☢	NM studies may be used for further evaluation of a suspected stress fracture not visible on XR

159

Chronic foot pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated only in specific circumstances	☢	Most patients can be managed on the basis of clinical findings without need for imaging. The cause of foot pain is rarely detectable on XR however XR is the first-line investigation for the imaging work-up of chronic foot pain. Pre-operative and post-operative evaluation of hallux valgus is best performed with weight-bearing AP and lateral XR of the feet.
MRI	Specialized investigation	○	If XR is unremarkable/equivocal and suspected tarsal coalition, plantar fasciitis, tarsal tunnel syndrome, painful accessory navicular, Morton's neuroma or inflammatory arthropathy

160

Chronic foot pain

Investigation	Recommendation	Radiation	Comments
US	Specialized investigation	○	If proper expertise is available, US can be used in place of MRI to investigate tendinopathy, plantar fasciitis, tarsal tunnel syndrome, suspected inflammatory arthropathy or Morton's neuroma
NM	Specialized investigation	☢☢☢	If suspected reflex sympathetic dystrophy (CRPS), synovitis, stress or insufficiency fractures or enthesopathy and an XR is negative/equivocal

161

Painful surgical prosthesis

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is indicated as the initial imaging to detect established loosening
NM	Indicated	☢☢☢	NM is valuable for the investigation of late complications. Imaging should be discussed with a NM specialist to determine the most appropriate procedure.
Image-guided aspiration	Specialized investigation	☢☢	Image-guided aspiration is particularly helpful if there is concern about infection
US	Specialized investigation	○	US is indicated if a peri-prosthetic abscess or superficial infection is suspected
MRI	Specialized investigation	○	MRI is indicated if there is concern about peri-prosthetic soft tissue abnormalities.

162

Upper extremities

1. Shoulder injury
2. Elbow trauma
3. Painful shoulder, impingement syndrome & rotator cuff
4. Shoulder instability
5. Wrist injury: suspected scaphoid fracture

163

Shoulder injury / Elbow trauma

Shoulder injury			
Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is the appropriate initial imaging modality

Elbow trauma			
Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is the appropriate initial imaging modality

164

Painful shoulder, impingement syndrome and rotator cuff tear

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR may demonstrate acromio-clavicular osteoarthrosis and acromial enthesophytes, subacromial space narrowing, tendon calcification and glenohumeral osteoarthritis
US	Specialized investigation	○	Provides dynamic assessment of shoulder impingement and demonstrates rotator cuff tears or tendinopathy.
MRI	Specialized investigation	○	MRI allows precise assessment of the extent of rotator cuff tears, and it also shows bursal inflammatory changes.

165

Shoulder instability

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	Assess glenohumeral congruence and demonstrates bony abnormalities (Bankart & Hills-Sachs fractures)
MRI	Indicated in specific circumstances	○	Glenoid labrum, glenohumeral ligaments, cartilage and synovial cavity are well delineated
CT arthro-graphy	Indicated in specific circumstances	☢ ☢	Glenoid labrum, glenohumeral ligaments, cartilage and synovial cavity are well delineated

166

Wrist injury: suspected scaphoid fracture

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR is the appropriate imaging modality. If a scaphoid fracture is suspected a scaphoid view should be requested. Delayed XR (at least 10 days)is appropriate if thers is high suspicion of a scaphoid fracture but normal initial XR
CT	Indicated in special circumstances	☢☢	If a scaphoid fracture pr other carpal fracture is suspected and the XR is normal CT is appropriate for further investigation
MRI	Indicated in special circumstances	○	If a scaphoid fracture is suspected and the XR is normal and early diagnosis is required, MRI is the preferred modality for further evaluatio
NM	Indicated in special circumstances	☢☢	If a scaphoid fracture is suspected and the XR is normal and early diagnosis is required, NM can be used for further evaluation but NM bone scan performed at least 48-72 hrs. post-injury to maximize sensitivity.

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Pediatrics

1. Headache: Chronic/recurrent
2. Headache: acute, sudden, severe, “thunderclap”
3. New onset torticollis: No history of trauma
4. Back pain
5. Pediatrics
6. Suspected child abuse (non-verbal child)
7. Suspected child abuse (verbal child)
8. Limb injury: comparison to other side
9. Hip pain or limping referrable to hip pathology
10. Limping child too young to localize symptoms
11. Focal bone pain
12. Suspected Osgood –Schlater disease
13. Idiopathic scoliosis

168

Headache: chronic/recurrent

Investigation	Recommendation	Radiation	Comments
MRI	Specialized investigation	○	In chronic/frequent headache with a normal neurological examination, the yield of imaging is low. MRI may be used to rule out CNS pathology, if there remains concern after an evaluation by a neurologist MRI is preferred to CT because of its superior anatomical resolution and lack of radiation Consideration should be given to MR venography to rule out venous sinus thrombosis
CT	Specialized investigation	☢ ☢	CT may be used to rule out a space occupying lesion, if there remains concern after an evaluation by a neurologist. CT may be considered where MRI is not available or MRI is contraindicated

169

Headache: acute, sudden, severe, “thunderclap”

Investigation	Recommendation	Radiation	Comments
CT	Indicated	☢ ☢	Although rare, aneurysmal hemorrhage can occur in children In cases of sudden, severe headache “thunderclap”, CT has excellent sensitivity and specificity for the detection of acute blood CTA is required for the detection and characterization of aneurysms and vascular malformations
MRI	Indicate	○	Diffusion weighted imaging, FLARE & GRE sequences should be used to maximize detection of acute blood MRA of the circle of Willis is required for the detection and characterization of aneurysms and vascular malformation

170

New onset torticollis: No history of trauma

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	Muscular causes are common, but XR is advised when history and physical examination are atypical
MRI	Specialized investigation	○	Persistent torticollis for one week justifies further imaging following orthopaedic or neurosurgical consultation. MRI is preferred to CT when available because of its superior definition of soft tissues and its lack of ionizing radiation
CT	Specialized investigation	☢☢	Persistent torticollis for one week justifies further imaging following orthopaedic or neurosurgical consultation. CT may be used if MRI is contraindicated

171

Back pain pediatric

Investigation	Recommendation	Radiation	Comments
NM	Indicated	☢☢	NM bone scan with SPECT of the spine can be used to localize the site of abnormality for further imaging
MRI	Specialized investigation	○	Persistent back pain in children may have an underlying cause and justifies investigation. Back pain with scoliosis or neurological signs merits imaging. Choice of imaging should be made in consultation with specialist to maximize yield
CT	Specialized investigation	☢☢☢	Persistent back pain in children may have an underlying cause and justifies investigation. Back pain with scoliosis or neurological signs merits imaging.

172

Suspected child abuse (non-verbal child)

Investigation	Recommendation	Radiation	Comments
XR skeletal survey	Indicated	☢☢	A skeletal survey with appropriate views of skull, spine, chest/ribs, pelvis, upper & lower limbs should be performed.
XR skeletal survey (after 2 weeks)	Specialized investigation	☢☢	A follow up skeletal survey can detect additional fractures and clarify equivocal lesions seen on the initial survey
NM (whole body bone scan)	Indicated	☢☢	Whole body bone scan can be complimentary to XR skeletal survey
CT head	Indicated	☢☢	Unenhanced CT of the head should be part of the initial work-up for skull fractures. CT is complimentary to MRI in the estimation of timing of injuries

173

Suspected child abuse (verbal child)

Investigation	Recommendation	Radiation	Comments
XR skeletal survey	Not indicated	☢☢	Injured bones/joints should be identified by history & physical examination
XR of individual bones	Indicated	☢	XR should be targeted to injure bones/joints
NM whole body	Not indicated	☢☢	Injured bones/joints should be identified by history & physical examination
CT head	Specialized examination	☢☢	CT of the head should be discussed with a child protection specialist on an individual basis guided by history and examination

174

Limb injury, comparison to other side

Investigation	Recommendation	Radiation	Comments
XR opposite joint/ bone	Not indicated	☢	Comparison views are rarely necessary to distinguish abnormal findings from normal changes related to growth
XR	Indicated	☢	XR is the most appropriate fist imaging examination for suspected a vascular necrosis and slipped femoral epiphysis. AP & Frog leg views recommended.
US	Indicated	○	US is the most appropriate initial imaging for suspected septic arthritis, transient synovitis, juvenile idiopathic arthritis or hemarthrosis. US has high sensitivity for the detection of hip fractures

175

Hip pain or limping referable to hip pathology

Investigation	Recommendation	Radiation	Comments
MRI	Specialized investigation	○	MRI is considered the modality of choice to assess avascular necrosis. MRI can be helpful in assessing inflammatory arthropathies
NM	Moderately indicated	☢ ☢	NM bone scan with pinhole views of the hips may be used to assess avascular necrosis if MRI not available

176

Limping child too young to localize symptoms

Investigation	Recommendation	Radiation	Comments
XR tibial/ fibula	Indicated	☢	In the initial evaluation XR may identify a toddler's fracture
US hip	Indicated	○	US may identify hip pathology US has high sensitivity for hip effusion
NM	Moderately indicated	☢ ☢	NM is moderately indicated following a negative XR & US. NM has higher radiation dose
MRI	Specialized investigation	○	MRI may be used instead of NM

177

Focal bone pain

Investigation	Recommendation	Radiation	Comments
XR	Indicated	☢	XR should be done first. It is less sensitive than MRI & NM
NM	Indicated	☢ ☢	Bone scan may be helpful if initial XR is normal or pain is non-localized
CT	Specialized investigation	☢ ☢ ☢	CT should be performed in consultation with an orthopaedic surgeon. CT & MRI may be used for surgical planning

178

Suspected Osgood-Schlatter disease

Investigation	Recommendation	Radiation	Comments
XR	Not indicated	☢	Osgood Schlatter disease is a clinical diagnosis XR may be considered if the diagnosis is unclear or if more serious bone pathology is suspected

179

Idiopathic scoliosis

Investigation	Recommendation	Radiation	Comments
XR full spine	indicated	☢ ☢	The presence of scoliosis should be established by physical examination. The purpose of radiographs is to quantify the degree of scoliosis Lateral views should be performed on curves greater than 10^{o}

180

Non- Idiopathic scoliosis

Investigation	Recommendation	Radiation	Comments
XR full spine	Indicated	☢☢	Should be performed for initial localization if vertebral tumor is suspected
NM	Indicated	☢☢	Should be performed for initial localization if vertebral tumor is suspected
CT	Indicated	☢☢☢	Should be targeted to focal bone pathology identified by XR or NM
MRI	Indicated	○	Should include sequences targeted to the pathology & cauda equina

181

Diagnostic Imaging Utilization

Unit 6

ACR criteria

Upper Extremities

182

ACR Appropriateness Criteria® 2022

ACR Appropriateness Criteria ® web site

https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria

ACR Appropriateness Criteria ® app

https://apps.apple.com/us/app/acr-appropriateness-criteria/id1078830466

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ACR Appropriateness Criteria® 2022

Criteria

- Clinical scenario (ie acute trauma to the ankle)

Variant

- The clinical scenario that the table relates to

Procedure

- The type of imaging procedure

Appropriateness category

- Colour coded for
  - Usually appropriate
  - May be appropriate
  - Usually not appropriate

Relative Radiation

- More radiation symbols ☢☢☢ indicate higher levels of radiation exposure to patient

Acutely Limping Child Up To Age 5.
Symptoms localized to hip. Concern for infection. Initial imaging

Procedure	Appropriateness	Radiation
US hips	Usually appropriate	0
MRI pelvis without and with IV contrast	Usually appropriate	0
MRI pelvis without IV contrast	Usually appropriate	0
3-phase bone scan pelvis and lower extremity	May be appropriate	☢☢☢☢
XR pelvis	May be appropriate	☢☢
XR lumbar spine	Usually not appropriate	☢☢
CT pelvis with IV contrast	Usually not appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually not appropriate	☢☢☢☢
CT pelvis without IV contrast	Usually not appropriate	☢☢☢☢

184

Shoulder Pain–Traumatic

Variant 1

- Traumatic shoulder pain. Any etiology. Initial imaging.

Variant 2:

- Traumatic shoulder pain. Non-localized shoulder pain. Negative radiographs. Next imaging study.

Variant 3:

- Traumatic shoulder pain. Radiographs show humeral head or neck fracture. Next imaging study.

Variant 4:

- Traumatic shoulder pain. Radiographs show scapula fracture. Next imaging study.

Variant 5:

- Traumatic shoulder pain. Radiographs show Bankart or Hill-Sachs lesion. Next imaging study.

Variant 6:

- Traumatic shoulder pain. Radiographs normal. Physical examination and history consistent with dislocation event or instability. Next imaging study.

185

Shoulder Pain–Traumatic

Variant 7:

- Traumatic shoulder pain. Radiographs normal. Physical examination findings consistent with labral tear. Next imaging study.

Variant 8:

- Traumatic shoulder pain. Radiographs normal. Physical examination findings consistent with rotator cuff tear. Next imaging study.

Variant 9:

- Traumatic shoulder pain. Radiographs already performed. Physical examination consistent with vascular compromise. Next imaging study.

Variant 10:

- Traumatic shoulder pain. Radiographs already performed. Neuropathic syndrome (excluding plexopathy). Next imaging study.

186

Traumatic Shoulder Pain
Any etiology Initial imaging

Procedure	Appropriateness	Radiation
XR shoulder	Usually appropriate	☢
CT arthrography shoulder	Usually not appropriate	☢☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI arthrography shoulder	Usually not appropriate	○
MRI shoulder without and with IV contrast	Usually not appropriate	○
MRI shoulder without IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

187

Traumatic Shoulder Pain.
Nonlocalized shoulder pain. Negative radiographs. Next imaging

Procedure	Appropriateness	Radiation
MRI shoulder without IV contrast	Usually appropriate	○
CT arthrography shoulder	May be appropriate	☢☢☢☢
MR arthrography shoulder	May be appropriate	○
US shoulder	May be appropriate	○
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without and with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢

188

Traumatic shoulder pain.
XR show humeral head or neck fracture. Next imaging

Procedure	Appropriateness	Radiation
CT shoulder without IV contrast	Usually appropriate	☢☢☢
MRI shoulder without IV contrast	Usually not appropriate	○
CT arthrography shoulder	Usually not appropriate	☢☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull to mid-thigh	Usually not appropriate	☢☢☢☢
MR arthrography shoulder	Usually not appropriate	○
MRI shoulder without and with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

189

Traumatic shoulder pain.
XR shows scapular fracture. Next imaging

Procedure	Appropriateness	Radiation
CT shoulder without IV contrast	Usually appropriate	☢☢☢
MRI shoulder without IV contrast	Usually not appropriate	○
CT arthrography shoulder	Usually not appropriate	☢☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MR arthrography shoulder	Usually not appropriate	○
MRI shoulder without & with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

190

Traumatic Shoulder Pain.
XR shows Bankart or Hills-Sachs lesion. Next imaging

Procedure	Appropriateness	Radiation
MR arthrography shoulder	Usually appropriate	○
MRI shoulder without IV contrast	Usually appropriate	○
CT arthrography shoulder	May be appropriate	☢☢☢☢
CT shoulder without IV contrast	May be appropriate	☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without & with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

191

Traumatic shoulder pain.
XR normal. Physical examination & history consistent with dislocation or instability. Next imaging.

Procedure	Appropriateness	Radiation
MRI arthrography shoulder	Usually appropriate	○
MRI shoulder without IV contrast	Usually appropriate	○
CT arthrography shoulder	May be appropriate	☢☢☢☢
CT shoulder without IV contrast	May be appropriate	☢☢☢
CT shoulder without & with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without & with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

192

Traumatic Shoulder Pain.
XR normal. Physical exam consistent with labral tear. Next imaging.

Procedure	Appropriateness	Radiation
MR arthrography shoulder	Usually appropriate	○
CT arthrography shoulder	Usually appropriate	☢☢☢☢
MRI shoulder without IV contrast	Usually appropriate	○
CT shoulder with IV contrast	Usually appropriate	☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without & with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without & with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

193

Traumatic Shoulder Pain.
XR normal. Physical exam consistent with rotator cuff tear. Next imaging.

Procedure	Appropriateness	Radiation
MRI shoulder without IV contrast	Usually appropriate	○
MR arthrography shoulder	Usually appropriate	○
US shoulder	Usually appropriate	○
CT arthrography shoulder	May be appropriate	☢☢☢☢
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
CT shoulder with & without IV contrast	Usually not appropriate	☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without & with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢

194

Traumatic Shoulder Pain.
RX performed. Physical exam consistent with vascular compromise. Next imaging.

Procedure	Appropriateness	Radiation
CT arthrography shoulder with IV contrast	Usually appropriate	☢☢☢
Arteriography shoulder	Usually appropriate	☢☢☢
US duplex Doppler shoulder	May be appropriate	○
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder with out & with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MR angiography shoulder with IV contrast	Usually not appropriate	○
MRI shoulder without & with IV contrast	Usually not appropriate	○
MRI shoulder without IV contrast	Usually not appropriate	○
3-phase bone scan shoulder	Usually not appropriate	☢☢☢

195

Shoulder Pain–Traumatic
XR performed. Neuropathic syndrome. Next imaging

Procedure	Appropriateness	Radiation
MRI shoulder without IV contrast	Usually appropriate	○
Bone scan shoulder	May be appropriate	☢☢☢
C T scan shoulder without IV contrast	Usually not appropriate	☢☢☢
CT arthrography shoulder	Usually not appropriate	☢☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without & with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull to base mid-thigh	Usually not appropriate	☢☢☢☢
MR arthrography shoulder	Usually not appropriate	○
MRI shoulder without & with IV contrast	Usually not appropriate	○
US shoulder	Usually not appropriate	○

196

Acute Hand and Wrist Trauma

Variant 1:

- Acute blunt or penetrating trauma to the hand or wrist. Initial imaging.

Variant 2:

- Suspect acute hand or wrist trauma. Initial radiographs negative or equivocal. Next imaging study.

Variant3:

- Acute wrist fracture on radiographs. Suspect wrist tendon or ligament trauma. Next imaging study.

Variant 4:

- Initial radiographs showing distal radioulnar joint or carpal malalignment in the absence of fracture. Next imaging study.

Variant 5:

- Acute hand fracture on radiographs. Suspect hand tendon or ligament trauma. Next imaging study.

Variant 6:

- Initial radiographs showing metacarpophalangeal, proximal interphalangeal, or distal interphalangeal joint malalignment in the absence of fracture. Next imaging study.

Variant 7:

- Suspect penetrating trauma with a foreign body in the soft tissues in the hand or wrist. Initial radiographs are negative. Next imaging study.

197

Acute blunt trauma to the hand or wrist Initial imaging

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
CT area of interest	Usually not appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
MRI are of interest without & with IV contrast	Usually not appropriate	○
MRI area of interest without IV contrast	Usually not appropriate	○
MRI area of interest without IV contrast	Usually not appropriate	○
Bone scan area of interest	Usually not appropriate	☢ ☢ ☢
US area of interest	Usually not appropriate	○

198

Suspect acute hand or wrist trauma.
Initial XR negative. Next imaging

Procedure	Appropriateness	Radiation
MRI area of interest without IV contrast	Usually appropriate	○
XR area of interest repeat 10-14 days	Usually appropriate	Varies
CT area of interest without IV contrast	Usually appropriate	Varies
CT area of interest with & with IV contrast	Usually appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
MRI area of interest without & with IV contrast	Usually not appropriate	○
Bone scan area of interest	Usually not appropriate	☢ ☢ ☢
US area of interest	Usually not appropriate	○

199

Acute wrist fracture on radiographs.
Suspected wrist tendon or ligament trauma. Next imaging.

Procedure	Appropriateness	Radiation
MR arthrography wrist	Usually appropriate	○
MRI wrist without IV contrast	Usually appropriate	○
CT arthrography wrist	Usually appropriate	☢
US wrist	Usually appropriate	○
CT wrist with IV contrast	Usually appropriate	☢
CT wrist without & with IV contrast	Usually not appropriate	☢
CT wrist without IV contrast	Usually not appropriate	☢
MRI wrist without & with IV contrast	Usually not appropriate	○
Bone scan wrist	Usually not appropriate	☢ ☢ ☢

200

Initial XR showing distal radio-ulnar or carpal malalignment in the absence of fracture. Next imaging

Procedure	Appropriateness	Radiation
CT wrist without IV contrast bilateral	Usually appropriate	☢
MRI wrist without IV contrast	Usually appropriate	○
MR arthrography wrist	Usually appropriate	○
CT arthrography wrist	May be appropriate	☢
CT wrist without & with IV contrast bilateral	Usually not appropriate	☢
CT wrist with IV contrast	Usually not appropriate	☢
MRI wrist without & with IV contrast	Usually not appropriate	○
Bone scan wrist	Usually not appropriate	☢ ☢ ☢
US wrist	Usually not appropriate	○

201

Acute hand fracture on XR. Suspect hand tendon or ligament trauma. Next imaging

Procedure	Appropriateness	Radiation
MRI hand with out IV contrast	Usually appropriate	○
US hand	Usually appropriate	○
CT hand with IV contrast	Usually not appropriate	☢
CT hand without & with IV contrast	Usually not appropriate	☢
CT hand without IV contrast	Usually not appropriate	☢
MRI hand without & with IV contrast	Usually not appropriate	○
Bone scan hand	Usually not appropriate	☢ ☢ ☢

202

Initial XR showing metacarpo-phalangeal, proximal inter-phalangeal or distal interphalangeal malalignment in the absence of fracture. Next imaging

Procedure	Appropriateness	Radiation
MRI hand without IV contrast	Usually appropriate	○
US hand	Usually appropriate	○
CT hand with IV contrast	Usually not appropriate	☢
CT hand without & with IV contrast	Usually not appropriate	☢
CT hand without IV contrast	Usually not appropriate	☢
MRI hand without & with IV contrast	Usually not appropriate	○
Bone scan hand	Usually not appropriate	☢☢☢

203

Suspect penetrating trauma with foreign body in hand or wrist. Initial XR negative. Next imaging.

Procedure	Appropriateness	Radiation
US area of interest	Usually appropriate	○
CT area of interest	Usually appropriate	Varies
MRI area of interest without IV contrast	May be appropriate	○
MRI area of interest without & with IV contrast	Usually not appropriate	○
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan area of interest	Usually not appropriate	☢☢☢

204

Suspected Physical Abuse–Child

Variant 1

- Suspected physical abuse. Child ≤24 months of age. Neurological or visceral injuries not clinically suspected. Initial imaging evaluation.

Variant 2:

- Suspected physical abuse. Child >24 months of age. Neurological or visceral injuries not clinically suspected. Initial imaging evaluation.

Variant 3:

- Child with one or more of the following: neurologic signs or symptoms, apnea, complex skull fracture, other fractures, or injuries highly suspicious for child abuse. Initial imaging evaluation.

Variant 4:

- Child. Suspected physical abuse. Suspected thoracic or abdominopelvic injuries (eg, abdominal skin bruises, distension, tenderness, or elevated liver or pancreatic enzymes).
- Initial imaging evaluation.

Variant 5:

- Child ≤24 months of age. High suspicion for abuse. Negative initial skeletal survey. Follow- up imaging evaluation.

205

Suspected Physical Abuse–Child.
Neurological or visceral injuries not clinically suspected. Initial imaging

Procedure	Appropriateness	Radiation
XR skeletal survey	Usually appropriate	☢☢☢
MRI head without IV contrast	Usually appropriate	○
CT head without IV contrast	May be appropriate	☢☢☢
Te-99m bone scan whole body	May be appropriate	☢☢☢☢
MRI head without and with IV contrast	Usually not appropriate	○
CT head with IV contrast	Usually not appropriate	☢☢☢
CT head without and with IV contrast	Usually not appropriate	☢☢☢☢

206

Suspected Physical Abuse–Child. Child > 24 months of age. Neurological or visceral injuries not clinically suspected. Initial imaging

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
CT head without IV contrast	May be appropriate	☢☢☢
MRI head without IV contrast	May be appropriate	○
Te-99m bone scan whole body	May be appropriate	☢☢☢☢
MRI head without and with IV contrast	Usually not appropriate	○
CT head with IV contrast	Usually not appropriate	☢☢☢
CT head without and with IV contrast	Usually not appropriate	☢☢☢☢

207

Child with one or more of the following: Neurological signs & symptoms, apnea, complex skull fracture, injuries suspicious of child abuse. Initial imaging

Procedure	Appropriateness	Radiation
XR skeletal survey	Usually appropriate	☢☢☢
CT head without IV contrast	Usually appropriate	☢☢☢
MRI head without IV contrast	Usually appropriate	○
MRI cervical spine without IV contrast	Usually appropriate	○
MRI complete spine without IV contrast	May be appropriate	○
Te-99m bone scan	May be appropriate	☢☢☢☢
MRI head without and with IV contrast	Usually not appropriate	○
MRI complete spine without and with IV contrast	Usually not appropriate	○
CT head with IV contrast	Usually not appropriate	☢☢☢
CT head without and with IV contrast	Usually not appropriate	☢☢☢☢

208

Child. Suspected Physical Abuse.
Suspected thoracic or abdomino-pelvic injuries. Initial imaging

Procedure	Appropriateness	Radiation
XR skeletal survey	Usually appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually appropriate	☢☢☢☢
CT chest with IV contrast	May be appropriate	☢☢☢☢
CT head without IV contrast	May be appropriate	☢☢☢
MRI head without IV contrast	May be appropriate	○
Te-99m bone scan whole body	My be appropriate	☢☢☢☢
CT chest without IV contrast	Usually not appropriate	☢☢☢☢
MRI head without and with IV contrast	Usually not appropriate	○
CT abdomen and pelvis without and with IV contrast	Usually not appropriate	☢☢☢☢
CT head with IV contrast	Usually not appropriate	☢☢☢
CT Head without and with IV contrast	Usually not appropriate	☢☢☢☢

209

Child < 24 months of age. High suspicion of abuse.
Negative initial skeletal survey. Follow-up imaging

Procedure	Appropriateness	Radiation
XR skeletal survey	Usually appropriate	☢☢☢
Te-99m bone scan whole body	May be appropriate	☢☢☢☢
CT chest without IV contrast	May be appropriate	☢☢☢☢
MRI head without IV contrast	May be appropriate	○
CT head without IV contrast	May be appropriate	☢☢☢
CT head without and with IV contrast	Usually not appropriate	☢☢☢☢
CT chest with IV contrast	Usually not appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually not appropriate	☢☢☢☢

210

Diagnostic Imaging Utilization

Unit 7

ACR criteria

Lower Extremities

211

Acutely Limping Child Up To Age 5

Variant 1

- Child up to age 5. Acute limp. Nonlocalized symptoms. No concern for infection. Initial imaging.

Variant 2:

- Child up to age 5. Acute limp. Pain. Localized symptoms. No concern for infection. Initial imaging.

Variant 3:

- Child up to age 5. Acute limp. Nonlocalized symptoms. Concern for infection. Initial imaging.

Variant 4:

- Child up to age 5. Acute limp. Symptoms localized to the hip. Concern for infection. Initial imaging.

Variant 5:

- Child up to age 5. Acute limp. Symptoms localized to lower extremity (not pelvis or hips). Concern for infection. Initial imaging.

212

Acutely Limping Child Up To Age 5
No localization. No concern for infection. Initial imaging

Procedure	Appropriateness	Radiation
XR tibia/fibula	Usually appropriate	☢
XR femur	May be appropriate	☢ ☢
XR foot	May be appropriate	☢
XR lumbar spine	Usually not appropriate	☢ ☢
XR pelvis	Usually not appropriate	☢ ☢ ☢ ☢ ☢
US hips	Usually not appropriate	◯
US lower extremity	Usually not appropriate	◯
CT lower extremity with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
CT lower extremity without IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
MRI lower extremity no IV contrast	Usually not appropriate	◯
MRI lower extremity with IV contrast	Usually not appropriate	◯
MRI whole-body no IV contrast	Usually not appropriate	◯
3-phase bone scan pelvis & lower extremity	Usually not appropriate	☢ ☢ ☢ ☢

213

Acutely Limping Child Up To Age 5
Pain Localized symptoms No concern for infection. Initial imaging

Procedure	Appropriateness	Radiation
XR lower extremity area of interest	Usually appropriate	☢ ☢
MRI lower extremity area of interest no IV contrast	Usually not appropriate	◯
US hips	Usually not appropriate	◯
US lower extremity area of interest	Usually not appropriate	◯
CT lower extremity area of interest with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
CT lower extremity area of interest with and without IV contrast	Usually not appropriate	☢ ☢ ☢ ☢ ☢
MRI lower extremity area of interest without IV contrast	Usually not appropriate	◯
MRI lower extremity area of interest with and without IV contrast	Usually not appropriate	◯
3-phase bone scan pelvis and lower extremity	Usually not appropriate	☢ ☢ ☢ ☢

214

Acutely Limping Child Up To Age 5
Non localized symptoms. Concern for infection. Initial imaging

Procedure	Appropriateness	Radiation
MRI lower extremity without and with IV contrast	Usually appropriate	○
MRI lower extremity without IV contrast	Usually appropriate	○
MRI whole-body without IV contrast	May be appropriate	○
Bone scan pelvis and lower extremity	May be appropriate	☢☢☢☢
US lower extremity	Usually not appropriate	○
XR femur	Usually not appropriate	☢☢
XR foot	Usually not appropriate	☢
XR lumbar spine	Usually not appropriate	☢☢
CT lower extremity with IV contrast	Usually not appropriate	☢☢☢☢
CT lower extremity without and with IV contrast	Usually not appropriate	☢☢☢☢☢
CT lower extremity without IV contrast	Usually not appropriate	☢☢☢☢

215

Acutely Limping Child Up To Age 5.
Symptoms localized to hip. Concern for infection. Initial imaging

Procedure	Appropriateness	Radiation
US hips	Usually appropriate	○
MRI pelvis without and with IV contrast	Usually appropriate	○
MRI pelvis without IV contrast	Usually appropriate	○
3-phase bone scan pelvis and lower extremity	May be appropriate	☢☢☢☢
XR pelvis	May be appropriate	☢☢
XR lumbar spine	Usually not appropriate	☢☢
CT pelvis with IV contrast	Usually not appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually not appropriate	☢☢☢☢
CT pelvis without IV contrast	Usually not appropriate	☢☢☢☢

216

Acutely Limping Child Up To Age 5.
Symptoms localized to lower extremity. Concerns for infection. Initial imaging

Procedure	Appropriateness	Radiation
MRI lower extremity area of interest without and with IV contrast	Usually appropriate	○
MRI lower extremity area of interest without contrast	Usually appropriate	○
US lower extremity area of interest	May be appropriate	○
XR lower extremity area of interest	May be appropriate	☢☢
CT lower extremity area of interest with IV contrast	Usually not appropriate	Varies
MRI whole-body without and with IV contrast	Usually not appropriate	○
MRI whole-body without IV contrast		○
3-phase bone scan pelvis and lower extremity	Usually not appropriate	☢☢☢☢
CT lower extremity area of interest without IV contrast	Usually not appropriate	Varies
CT lower extremity area of interest without and with IV contrast	Usually not appropriate	Varies

217

Acute Hip Pain-Suspected Fracture

Variant 1
- Acute hip pain.
- Fall or minor trauma.
- Suspect fracture.
- Initial imaging.

Variant 2:
- Acute hip pain.
- Fall or minor trauma.
- Negative radiographs.
- Suspect fracture.
- Next imaging study.

218

Acute Hip Pain.
Fall or minor trauma. Suspected Fracture. Initial imaging

Procedure	Appropriateness	Radiation
XR hip	Usually appropriate	☢ ☢ ☢
XR pelvis	Usually appropriate	☢ ☢
XR pelvis & hip	Usually appropriate	☢ ☢ ☢
CT pelvis & hips with IV contrast	Usually not appropriate	☢ ☢ ☢
CT pelvis & hips without & with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
MRI pelvis & affected hip without & with IV contrast	Usually not appropriate	○
MRI pelvis & affected hip without IV contrast	Usually not appropriate	○
Bone scan hips	Usually not appropriate	☢ ☢ ☢
US hips	Usually not appropriate	○

219

Acute Hip Pain.
Fall or minor trauma. Negative XR. Suspected Fracture. Next imaging

Procedure	Appropriateness	Radiation
MRI pelvis & affected hip without IV contrast	Usually appropriate	○
CT pelvis & hips without IV contrast	Usually appropriate	☢ ☢ ☢
CT pelvis & hips with IV contrast	Usually not appropriate	☢ ☢ ☢
CT pelvis & affected hip without & with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
MRI pelvis & affected hip without & with IV contrast	Usually not appropriate	○
Bone scan hips	Usually not appropriate	☢ ☢ ☢
US hips	Usually not appropriate	○

220

Acute Trauma to the Knee

Variant 1
- Adult or child 5 years of age or older.
- Fall or acute twisting trauma to the knee.
- No focal tenderness, no effusion, able to walk.
- Initial imaging.

Variant 2:
- Adult or child 5 years of age or older.
- Fall or acute twisting trauma to the knee.
- One or more of the following: focal tenderness, effusion, inability to bear weight.
- Initial imaging.

Variant 3:
- Adult or skeletally mature child.
- Fall or acute twisting trauma to the knee.
- No fracture seen on radiographs.
- Suspect occult fracture or internal derangement.
- Next study.

Variant 4:
- Skeletally immature child.
- Fall or acute twisting trauma to the knee.
- No fracture seen on radiographs.
- Suspect occult fracture or internal derangement.
- Next study.

221

Acute Trauma to the Knee

Variant 5:
- Adult or child 5 years of age or older.
- Fall or acute twisting trauma to the knee.
- Tibial plateau fracture on radiographs.
- Suspect additional bone or soft-tissue injury.
- Next study.

Variant 6:
- Adult or child 5 years of age or older.
- Acute trauma to the knee.
- Mechanism unknown.
- Focal patellar tenderness, effusion, able to walk.
- Initial imaging.

Variant 7:
- Adult or child 5 years of age or older.
- Significant trauma to the knee (eg, motor vehicle accident, knee dislocation).
- Initial imaging.

222

Adult or child > 4 yrs.

Fall or acute trauma to the knee. No focal tenderness/effusion, able to walk. Initial imaging.

Procedure	Appropriateness	Radiation
XR knee	May be appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
CT knee without & with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

223

Adult or child > 4 yrs.

Fall or acute twisting trauma to knee. 1 or more of: focal tenderness, effusion, inability to weight bear. Initial imaging.

Procedure	Appropriateness	Radiation
XR knee	Usually appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢ ☢ ☢
CT knee without IV contrast	Usually not appropriate	☢
MRI knee without & with IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

224

Adult or skeletally mature child.

Fall or acute twisting injury to the knee. No fracture seen on XR. Suspect occult fracture or internal derangement. Next study.

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
CT knee without IV contrast	May be appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

225

Skeletally immature child.

Fall or twisting injury to knee. No fracture seen on XR. Suspect occult fracture or internal derangement. Next study

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
CT knee without IV contrast	May be appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
CT knee without & with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

226

Adult or child >4 yrs.

Fall or acute twisting injury to knee. Tibial plateau fracture on XR.
Suspect additional bone or soft-tissue injury. Next study.

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
CT knee without IV contrast	Usually appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
CT knee without & with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

227

Adult or child > 4 yrs.

Acute trauma to knee, Mechanism unknown.
Focal patellar tenderness, effusion, able to walk. Initial imaging

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
CT knee without & with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

228

Adult or child <5 yrs.
Significant trauma to knee. Initial imaging

Procedure	Appropriateness	Radiation
XR knee	Usually appropriate	☢
CT arteriography lower limb with IV contrast	Usually appropriate	☢☢☢
Arteriography lower extremity	May be appropriate	☢☢
CT knee with IV contrast	May be appropriate	☢
CT knee without IV contrast	May be appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
Bone scan with SPECT	Usually not appropriate	☢☢☢
CT knee without & with IV contrast	Usually not appropriate	☢
MRI knee without & with IV contrast	Usually not appropriate	○
US Knee	Usually not appropriate	○

229

Acute Trauma to the Ankle

Variant 1

- Adult or child 5 years of age or older.
- Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 3 weeks.
- No exclusionary criteria present.
- Initial imaging.
- Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive:
  1. Inability to bear weight immediately after the injury, OR
  2. Point tenderness over the medial malleolus, the posterior edge or inferior tip of the lateral malleolus, talus, or calcaneus, OR
  3. Inability to ambulate for 4 steps in the emergency department.

Variant 2:

- Adult or child 5 years of age or older.
- Acute trauma to the ankle.
- No exclusionary criteria present (eg, neurologically intact (including no peripheral neuropathy)).
- Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are negative:
- No point tenderness over the malleoli, talus, or calcaneus on physical examination.
- Able to walk.
- Initial imaging.

230

Adult or child >4 yrs.

Acute trauma to ankle or post-trauma persistent pain >1/< 3 wks.
Ottawa ankle rules positive.

Procedure	Appropriateness	Radiation
XR ankle	Usually appropriate	☢
US ankle	Usually not appropriate	○
MRI ankle without & with IV contrast	Usually not appropriate	○
MRI ankle without IV contrast	Usually not appropriate	○
CT ankle without & with IV contrast	Usually not appropriate	☢
CT ankle without IV contrast	Usually not appropriate	☢
Bone scan ankle	Usually not appropriate	☢ ☢ ☢

231

Adult or child > 4yrs.

Acute trauma to ankle. Ottawa ankle rules negative. Initial imaging.

Procedure	Appropriateness	Radiation
US ankle	Usually not appropriate	○
XR ankle	Usually not appropriate	☢
MRI ankle without & with IV contrast	Usually not appropriate	○
MRI ankle without IV contrast	Usually not appropriate	○
CT ankle without IV contrast	Usually not appropriate	☢
CT ankle without & with IV contrast	Usually not appropriate	☢
CT ankle without IV contrast	Usually not appropriate	☢
Bone scan ankle	Usually not appropriate	☢ ☢ ☢

232

Acute Trauma to the Foot

Variant 1

- Adult or child older than 5 years of age.
- Acute trauma to the foot.
- Ottawa rules can be evaluated without exclusionary criteria.
- Ottawa rules are negative.
- No suspected abnormalities in regions not evaluated by the Ottawa rules.
- Initial imaging.

Variant 2:

- Adult or child older than 5 years of age.
- Acute trauma to the foot.
- Ottawa rules can be evaluated without exclusionary criteria.
- Ottawa rules are positive.
- Initial imaging.

Variant 3:

- Adult or child older than 5 years of age.
- Acute trauma to the foot.
- Ottawa rules cannot be evaluated due to exclusionary criteria.
- Initial imaging.

233

Acute Trauma to the Foot

Variant 4:

- Adult or child older than 5 years of age.
- Acute trauma to the foot. Ottawa rules can be evaluated without exclusionary criteria.
- Ottawa rules are negative.
- Suspected pathology in an anatomic area not addressed by Ottawa rules (not involving the midfoot; eg, metatarsal- phalangeal joint, metatarsal, toe, tendon, etc).
- Initial imaging.

Variant 5:

- Adult or child older than 5 years of age.
- Acute trauma to the foot. Suspect Lisfranc injury, tendon injury, or occult fracture or dislocation.
- Radiographs are normal or equivocal.
- Next imaging study.

Variant 6:

- Adult or child older than 5 years of age.
- Acute trauma to the foot.
- Suspect penetrating trauma with a foreign body.
- Radiographs of the foot are negative.
- Next imaging study.

234

Ault or child > 5 yrs.

Acute trauma to the foot. Ottawa foot rules negative. Initial imaging.

Procedure	Appropriateness	Radiation
XR foot	Usually not appropriate	☢
CT foot without IV contrast	Usually not appropriate	☢ ☢
CT foot with IV contrast	Usually not appropriate	☢ ☢
CT foot without & with IV contrast	Usually not appropriate	☢ ☢
MRI foot without IV contrast	Usually not appropriate	○
MRI foot without & with IV contrast	Usually not appropriate	○
US foot	Usually not appropriate	○

235

Ault or child > 5 yrs.

Acute trauma to the foot. Ottawa foot rules positive. Initial imaging.

Procedure	Appropriateness	Radiation
XR foot	Usually appropriate	☢
CT foot without IV contrast	Usually not appropriate	☢ ☢
CT foot with IV contrast	Usually not appropriate	☢ ☢
CT foot without & with IV contrast	Usually not appropriate	☢ ☢
MRI foot without IV contrast	Usually not appropriate	○
MRI foot without & with IV contrast	Usually not appropriate	○
US foot	Usually not appropriate	○

236

Adult or child > 5 yrs.

Acute trauma to foot. Ottawa rules negative.

Suspected pathology in area outside Ottawa rules. Initial imaging.

Procedure	Appropriateness	Radiation
XR foot	Usually appropriate	☢
XR foot weight bearing	Usually appropriate	☢
CT foot without IV contrast	May be appropriate	☢ ☢
CT foot with IV contrast	May be appropriate	☢ ☢
CT foot without & with IV contrast	Usually not appropriate	☢ ☢
Fluoroscopy foot	Usually not appropriate	☢ ☢
MRI foot without & with IV contrast	Usually not appropriate	○
MRI without IV contrast	Usually not appropriate	○
US foot	Usually not appropriate	○

237

Adult or child > 5 yrs.

Acute trauma to foot. Suspected Lisfranc injury, tendon injury or occult fracture/ dislocation. XR normal. Next imaging.

Procedure	Appropriateness	Radiation
CT foot without IV contrast	Usually appropriate	☢ ☢
MRI foot without IV contrast	Usually appropriate	○
US foot	May be appropriate	○
CT foot with IV contrast	May be appropriate	☢ ☢
CT foot without & with IV contrast	Usually not appropriate	☢ ☢
MRI foot without & with IV contrast	Usually not appropriate	○

238

Adult or child > 5 yrs.
Acute trauma to foot. Suspect penetrating trauma with foreign body.
XR negative. Next imaging.

Procedure	Appropriateness	Radiation
US foot	Usually appropriate	○
CT foot without IV contrast	May be appropriate	☢ ☢
MRI foot without Iv contrast	May be appropriate	○
CT foot with IV contrast	Usually not appropriate	☢ ☢
MRI foot without & with IV contrast	Usually not appropriate	○
CT foot with IV contrast	Usually not appropriate	☢ ☢

239

Diagnostic Imaging Utilization

Unit 8

ACR criteria

Spine

240

Suspected Spine Trauma

Variant 1

- Age greater than or equal to 16 years and less than 65 years. Suspected acute blunt cervical spine trauma; imaging not indicated by NEXUS or CCR clinical criteria. Patient meets low- risk criteria. Initial imaging.

Variant 2:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Imaging indicated by NEXUS or CCR clinical criteria. Initial imaging.

Variant 3:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Confirmed or suspected cervical spinal cord or nerve root injury, with or without traumatic injury identified on cervical CT. Next imaging study.

Variant 4:

- Age greater than or equal to 16 years. Acute cervical spine injury detected on radiographs. Treatment planning for mechanically unstable spine.

Variant 5:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Clinical or imaging findings suggest arterial injury with or without positive cervical spine CT. Next imaging study.

241

Suspected Spine Trauma (cont.)

Variant 6:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Obtunded patient with no traumatic injury identified on cervical spine CT. Next imaging study after CT cervical spine without IV contrast.

Variant 7:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Clinical or imaging findings suggest ligamentous injury. Next imaging study after CT cervical spine without IV contrast.

Variant 8:

- Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Follow- up imaging on patient with no unstable injury demonstrated initially, but kept in collar for neck pain. No new neurologic symptoms. Includes whiplash associated disorders.

Variant 9:

- Age greater than or equal to 16 years. Blunt trauma meeting criteria for thoracic and lumbar imaging. Initial imaging.

Variant 10:

- Age greater than or equal to 16 years. Acute thoracic or lumbar spine injury detected on radiographs or non-contrast CT. Neurologic abnormalities. Next imaging study.

242

Age greater than or equal to 16 yrs. < 65 yrs.

Suspected acute blunt cervical spine trauma; imaging not indicated by NEXUS or CCR clinical criteria. Patient meets low- risk criteria. Initial imaging.

Procedure	Appropriateness	Radiation
CT cervical spine with IV contrast	Usually not appropriate	☢☢☢
CT cervical spine without & with IV contrast	Usually not appropriate	☢☢☢
CT cervical spine without IV contrast	Usually not appropriate	☢☢☢
CT myelography cervical spine	Usually not appropriate	☢☢☢☢
MRI cervical spine without IV contrast	Usually not appropriate	◯
MRI cervical spine without & with IV contrast	Usually not appropriate	◯
XR cervical spine	Usually not appropriate	☢☢

243

Age > 15 yrs.

Suspected acute cervical blunt trauma. Imaging indicated by NEXUX or CCR. Initial imaging

Procedure	Appropriateness	Radiation
CT cervical spine without IV contrast	Usually appropriate	☢☢☢
XR cervical spine	May be appropriate	☢☢
CT cervical spine with IV contrast	Usually not appropriate	☢☢☢
CT cervical spine without & with IV contrast	Usually not appropriate	☢☢☢
CT myelography cervical spine	Usually not appropriate	☢☢☢☢
CT head & neck without IV contrast	Usually not appropriate	☢☢☢
MRI cervical spine without & with IV contrast	Usually not appropriate	◯
MRI cervical spine without IV contrast	Usually not appropriate	◯

244

Age> 15 yrs.
Suspected acute cervical spine blunt trauma. Suspected spinal canal or nerve root injury, with or without injury identified on cervical CT. Next imaging.

Procedure	Appropriateness	Radiation
MRI cervical spine without IV contrast	Usually appropriate	◯
CT myelography cervical spine	May be appropriate	☢ ☢ ☢ ☢
MRI cervical spine without & with IV contrast	Usually not appropriate	◯
XR cervical spine	Usually not appropriate	☢ ☢

245

Age > 15 yrs.
Acute cervical spine injury detected on XR. Treatment planning for mechanically unstable spine.

Procedure	Appropriateness	Radiation
CT cervical spine without IV contrast	Usually appropriate	☢ ☢ ☢
MRI cervical spine without IV contrast	Usually appropriate	◯
CT cervical spine without IV contrast	Usually not appropriate	☢ ☢ ☢
CT cervical spine without & with IV contrast	Usually not appropriate	☢ ☢ ☢
CT myelography cervical spine	Usually not appropriate	☢ ☢ ☢ ☢
MRI cervical spine without & with IV contrast	Usually not appropriate	◯

246

Age >15 yrs.
Suspected acute cervical spine blunt trauma.
Clinical or imaging findings suggest arteria injury with or without positive cervical CT. Next imaging.

Procedure	Appropriateness	Radiation
CT arteriography head & neck with IV contrast	Usually appropriate	☢ ☢ ☢
MR arteriography neck with & without IV contrast	Usually appropriate	◯
Cervico-cerebral arteriography	May be appropriate	☢ ☢ ☢
MR arteriography without IV contrast	May be appropriate	◯

247

Age > 15 yrs.
Suspected acute cervical spine blunt trauma. No injury identified on cervical CT.
Next imaging

Procedure	Appropriateness	Radiation
MRI cervical spine without IV contrast	Usually appropriate	◯
CT myelography cervical spine	Usually not appropriate	☢ ☢ ☢ ☢
MRI cervical spine without & with IV contrast	Usually not appropriate	◯
XR cervical spine	Usually not appropriate	☢ ☢

248

Age > 15 yrs.

Suspected acute cervical spine blunt trauma. Clinical or imaging findings suggest ligamentous injury. Next imaging after CT without IV contrast

Procedure	Appropriateness	Radiation
MRI cervical spine without IV contrast	Usually appropriate	◯
CT myelography cervical spine	Usually not appropriate	☢☢☢
CT arteriography cervical spine	Usually not appropriate	☢☢☢☢
MR arteriography without IV contrast cervical spine	Usually not appropriate	◯
MR arteriography without & with IV contrast cervical spine	Usually not appropriate	◯
MRI cervical spine without & with IV contrast	Usually not appropriate	◯
XR cervical spine	Usually not appropriate	☢☢

249

Age > 15 yrs.

Suspected acute cervical blunt trauma. Follow-up imaging on patient with no unstable injury seen initially but kept in collar for neck pain. No new neurological symptoms. Includes WAD

Procedure	Appropriateness	Radiation
CT cervical spine without IV contrast	May be appropriate	☢☢☢
MRI cervical spine without IV contrast	May be appropriate	◯
XR cervical spine	May be appropriate	☢☢
CT cervical spine with IV contrast	Usually not appropriate	☢☢☢
CT cervical spine without & with IV contrast	Usually not appropriate	☢☢☢
CT myelography cervical spine	Usually not appropriate	☢☢☢☢
MRI cervical spine without & with IV contrast	Usually not appropriate	◯

250

Age > 15 yrs.

Blunt trauma meeting criteria for thoracic & lumbar imaging. Initial imaging.

Procedure	Appropriateness	Radiation
CT thoracic & lumbar spine without IV contrast	Usually appropriate	☢☢☢
XR thoracic & lumbar spine	May be appropriate	☢☢☢
CT myelography thoracic & lumbar spine	Usually not appropriate	☢☢☢☢
CT thoracic & lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT thoracic & lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢
MRI thoracic & lumbar spine without & with IV contrast	Usually not appropriate	◯
MRI thoracic & lumbar spine without IV contrast	Usually not appropriate	◯

251

Age >15 yrs.

Acute thoracic or lumbar injury detected on XR or non-contrast CT. Neurological abnormalities. Next imaging.

Procedure	Appropriateness	Radiation
MRI thoracic & lumbar spine without IV contrast	Usually appropriate	◯
CT myelography thoracic & lumbar spine	May be appropriate	☢☢☢☢
CT thoracic & lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT thoracic & lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢
MRI thoracic & lumbar spine without & with IV contrast	Usually not appropriate	◯

252

Low back pain

Variant 1

- Acute, subacute, or chronic uncomplicated low back pain or radiculopathy. No red flags. No prior management.

Variant 2:

- Acute, subacute, or chronic uncomplicated low back pain or radiculopathy. One or more of the following: low velocity trauma, osteoporosis, elderly individual, or chronic steroid use.

Variant 3:

- Acute, subacute, or chronic low back pain or radiculopathy. One or more of the following: suspicion of cancer, infection, or immunosuppression.

Variant 4:

- Acute, subacute, or chronic low back pain or radiculopathy. Surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of conservative management.

Variant 5:

- Low back pain or radiculopathy. New or progressing symptoms or clinical findings with history of prior lumbar surgery.

Variant 6:

- Low back pain with suspected cauda equina syndrome or rapidly progressive neurologic deficit.

253

Acute, subacute or chronic uncomplicated low back pain or radiculopathy. No red flags. No prior management.

Procedure	Appropriateness	Radiation
MRI lumbar spine without IV contrast	Usually not appropriate	○
XR lumbar spine	Usually not appropriate	☢☢☢
CT myelography lumbar spine	Usually not appropriate	☢☢☢☢
Te-99m bone scan with SPECT spine	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
MRI lumbar spine without & with IV contrast	Usually not appropriate	○
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢

254

Acute, subacute or chronic uncomplicated low back pain or radiculopathy.
1 or more of: low velocity trauma, osteoporosis, elderly individual, chronic steroid use.

Procedure	Appropriateness	Radiation
XR lumbar spine	Usually appropriate	☢☢☢
CT lumbar spine	Usually appropriate	☢☢☢
MRI lumbar spine without Iv contrast	Usually appropriate	◯
Te-99m bone scan with SPECT	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢
CT myelography lumbar spine	Usually not appropriate	☢☢☢☢
Discography & post-discography CT lumbar spine	Usually not appropriate	☢☢☢

255

Acute, subacute or chronic low back pain or radiculopathy.
1 or: suspicion of cancer, infection or immunosuppression.

Procedure	Appropriateness	Radiation
MRI lumbar spine without & with IV contrast	Usually appropriate	◯
MRI lumbar spine without IV contrast	Usually appropriate	◯
CT lumbar spine with IV contrast	May be appropriate	☢☢☢
CT lumbar spine without IV contrast	May be appropriate	☢☢☢
XR lumbar spine	May be appropriate	☢☢☢
Te-99 bone scan whole body with SPECT	May be appropriate	☢☢☢☢
PET/CT whole body	Usually not appropriate	☢☢☢☢
CT myelography lumbar spine	Usually not appropriate	☢☢

256

Acute, subacute or chronic low back pain or radiculopathy.
Surgery or intervention candidate with persistent or progressive symptoms following 6 wks. of conservative management.

Procedure	Appropriateness	Radiation
MRI lumbar spine without IV contrast	Usually appropriate	○
CT lumbar spine with IV contrast	May be appropriate	☢☢☢
CT lumbar spine without IV contrast	May be appropriate	☢☢☢
MRI lumbar spine without & with IV contrast	May be appropriate	○
CT myelography lumbar spine	May be appropriate	☢☢☢
XR lumbar spine	May be appropriate	☢☢☢
Te-99m bone scan with SPECT	May be appropriate	☢☢☢
Discography & post-discography CT lumbar spine	Usually not appropriate	☢☢☢☢
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢

257

Low back pain or radiculopathy.
New or progressing symptoms or clinical findings with history of prior lumbar surgery.

Procedure	Appropriateness	Radiation
MRI lumbar spine without & with IV contrast	Usually appropriate	○
CT lumbar spine with IV contrast	May be appropriate	☢☢☢
CT lumbar spine without IV contrast	May be appropriate	☢☢☢
MRI lumbar spine without IV contrast	May be appropriate	○
CT myelography lumbar spine	May be appropriate	☢☢☢☢
XR lumbar spine	May be appropriate	☢☢☢
Te-99m bone scan with SPECT	May be appropriate	☢☢☢
Discography & post-discography CT lumbar spine	May be appropriate	☢☢☢
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢

258

Low back pain with suspected cauda equina syndrome or rapidly progressing neurologic deficit.

Procedure	Appropriateness	Radiation
MRI lumbar spine without IV contrast	Usually appropriate	◯
MRI lumbar spine without & with IV contrast	Usually appropriate	◯
CT myelography without & with IV contrast	May be appropriate	☢☢☢☢
CT lumbar spine with IV contrast	May be appropriate	☢☢☢
CT lumbar spine without IV contrast	May be appropriate	☢☢☢
XR lumbar spine	Usually not appropriate	☢☢☢
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢
Te-99m bone scan with SPECT	Usually not appropriate	☢☢☢

259

Management of Vertebral Compression Fractures

Variant 1
- New symptomatic compression fracture identified on radiographs or CT. No known malignancy.

Variant 2:
- Osteoporotic compression fracture, with or without edema on MRI and no “red flags”. With or without spinal deformity, worsening symptoms, or pulmonary dysfunction.

Variant 3:
- Painful osteoporotic compression fracture with edema on MRI. Contraindication to vertebral augmentation or surgery (eg, fitness, pregnancy, infection, coagulation disorder, etc).

Variant 4:
- Known malignancy and new back pain. Compression fracture identified on radiographs or CT.

Variant 5:
- Asymptomatic pathologic spinal fracture with or without edema on MRI.

Variant 6:
- Pathologic spinal fracture with severe and worsening pain.

Variant 7:
- Pathologic spinal fracture with spinal deformity or pulmonary dysfunction.

Variant 8:
- Pathologic spinal fracture with neurologic deficits.

260

New symptomatic compression fracture identified on XR or CT. No know malignancy

Procedure	Appropriateness	Radiation
MRI spine area of interest without IV contrast	Usually appropriate	◯
CT spine area of interest without IV contrast	Usually appropriate	☢☢☢
Bone scan whole body	May be appropriate	☢☢☢
SPECT or SPECT/CT spine area of interest	May be appropriate	☢☢☢☢
CT spine area of interest with IV contrast	Usually not appropriate	☢☢☢
CT spine area of interest without & with IV contrast	Usually not appropriate	☢☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI area of interest with IV contrast	Usually not appropriate	◯
MRI area of interest without & with IV contrast	Usually not appropriate	◯

261

Known malignancy & new back pain. Compression fracture identified on XR or CT

Procedure	Appropriateness	Radiation
MRI spine area of interest without & with IV contrast	Usually appropriate	◯
PET/CT skull base to mid-thigh	May be appropriate	◯
MRI spine area of interest without IV contrast	May be appropriate	◯
Bone scan whole body	May be appropriate	☢☢☢☢
SPECT or SPECT/CT spine area of interest	May be appropriate	☢☢☢☢
MRI spine area of interest with IV contrast	May be appropriate	◯

262

Rib Fractures

Variant 1

- Suspected rib fractures from minor blunt trauma (injury confined to ribs). Initial imaging.

Variant 2:

- Suspected rib fractures after cardiopulmonary resuscitation (CPR). Initial imaging.

Variant 3:

- Suspected pathologic rib fracture. Initial imaging.

263

Suspected rib fractures from minor blunt trauma. Initial imaging

Procedure	Appropriateness	Radiation
XR chest	Usually appropriate	☢
XR rib view	May be appropriate	☢ ☢ ☢
CT chest without IV contrast	Usually not appropriate	☢ ☢ ☢
CT chest without & with IV contrast	Usually not appropriate	☢ ☢ ☢
US chest	Usually not appropriate	○

264

Suspected rib fractures after cardiopulmonary resuscitation (CPR).
Initial imaging

Procedure	Appropriateness	Radiation
XR chest	Usually appropriate	
XR rib view	May be appropriate	
CT chest without IV contrast	Usually not appropriate	
Bone scan whole body	Usually not appropriate	
US chest	Usually not appropriate	
CT chest without & with IV contrast	Usually not appropriate	

265

Suspected pathologic rib fracture.
Initial imaging.

Procedure	Appropriateness	Radiation
XR chest	Usually appropriate	
CT chest without IV contrast	Usually not appropriate	
Bone scan whole body	Usually not appropriate	
PET/CT skull to mid-thigh	Usually not appropriate	
XR rib view	Usually not appropriate	
CT chest with IV contrast	Usually not appropriate	
CT chest without & with IV contrast	Usually not appropriate	
US chest	Usually not appropriate	

266

Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae

Variant 1:

- Suspected stress (fatigue) fracture, excluding vertebrae. First imaging study.

Variant 2:

- Suspected stress (fatigue) fracture, hip. Negative radiographs. Next imaging study.

Variant 3:

- Suspected stress (fatigue) fracture, excluding hip and vertebrae. Negative radiographs. Next imaging study.

Variant 4:

- Suspected stress (fatigue) fracture, excluding vertebrae. Negative radiographs. Immediate "need-to-know" diagnosis. Next imaging study.

Variant 5:

- Confirmed stress (fatigue) fracture, excluding vertebrae. Follow-up imaging study for "return-to-play" evaluation.

Variant 6:

- Suspected stress (insufficiency) fracture, pelvis or hip. First imaging study.

267

Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae (cont.)

Variant 7:

- Suspected stress (insufficiency) fracture, pelvis or hip. Negative radiographs. Next imaging study.

Variant 8:

- Suspected stress (insufficiency) fracture of lower extremity, excluding pelvis and hip. First imaging study.

Variant 9:

- Suspected stress (insufficiency) fracture of lower extremity, excluding pelvis and hip. Negative radiographs. Next imaging study.

Variant 10:

- Follow-up imaging study for characterizing nonspecific focal uptake on Tc-99m MDP bone scintigraphy, suspected to be a stress fracture.

Variant 11:

- Suspect stress (fatigue or insufficiency) fracture, pelvis or hip or sacrum. Pregnant patient.

Variant 12:

- Suspect stress (fatigue or insufficiency) fracture of the long bones. Pregnant patient.

268

Suspected stress (fatigue) fracture sacrum excluding vertebrae. Initial imaging.

Procedure	Appropriateness	Radiation
XR chest	Usually appropriate	Varies
MRI area of interest without IV contrast	Usually not appropriate	◯
MRI area of interest without & with IV contrast	Usually not appropriate	◯
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest without IV contrast	Usually not appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢
US are of interest	Usually not appropriate	◯

269

Suspected stress (fatigue) fracture hip. Negative XR. Next imaging.

Procedure	Appropriateness	Radiation
MRI hip without IV contrast	Usually appropriate	◯
Bone scan whole body with SPECT or SPECT/CT hip	May be appropriate	☢ ☢ ☢
XR hip repeat in 10-14 days	May be appropriate	☢ ☢ ☢
CT hip without IV contrast	May be appropriate	☢ ☢ ☢
MRI hip without & with IV contrast	Usually not appropriate	◯
CT hip with IV contrast	Usually not appropriate	☢ ☢ ☢
CT hip without & with IV contrast	Usually not appropriate	☢ ☢ ☢
US hip	Usually not appropriate	◯

270

Suspected stress (fatigue) fracture, excluding hip & vertebrae.
Negative XR. Next imaging.

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
MRI area of interest	Usually appropriate	◯
CT area of interest without IV contrast	May be appropriate	varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
US area of interest	Usually not appropriate	◯

271

Suspected stress (fatigue) fracture excluding vertebrae.
Negative XR. Immediate “need-to know” diagnosis. Next imaging

Procedure	Appropriateness	Radiation
MRI area of interest without IV contrast	Usually appropriate	◯
CT area of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢
XR area of interest	Usually not appropriate	Varies
MRI area of interest with IV contrast	Usually not appropriate	◯
CT area of interest with IV contrast	With IV contrast	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
US area of interest	Usually not appropriate	◯

272

Confirmed stress (fatigue) fracture excluding vertebrae.

Follow-up imaging for “return-to-play” evaluation.

Procedure	Appropriateness	Radiation
DEXA total body composition	Usually appropriate	◯
CT area of interest without IV contrast	May be appropriate	Varies
Repeat XR area of interest in 10-14 days	May be appropriate	Varies
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest with IV contrast	Usually not appropriate	☢ ☢ ☢
Bone scan whole body with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢
US area of interest	Usually not appropriate	◯

273

Suspected stress (fatigue) fracture, pelvis or hip.

Initial imaging.

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
MRI area of interest without IV contrast	May be appropriate	◯
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest without IV contrast	Usually not appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢
US area of interest	Usually not appropriate	◯

274

Suspected stress (fatigue) fracture pelvis or hip. Negative XR. Next imaging

Procedure	Appropriateness	Radiation
MRI area of interest without IV contrast	Usually appropriate	◯
CT area of interest without IV contrast	Usually appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢
Repeate XR area of interest in 10-14 days	May be appropriate	Varies
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest without & with IV contrast	Usually not appropriate	Varies
US area of interest	Usually not appropriate	◯

275

Suspected stress (insufficiency) fracture of lower extremity, excluding pelvis & hip. First imaging

Procedure	Appropriateness	Radiation
XR lower extremity area of interest	Usually appropriate	☢
MRI lower extremity area of interest without Iv contrast	Usually not appropriate	◯
CT lower extremity area of interest without Iv contrast	Usually not appropriate	Varies
MRI lower extremity area of interest without IV contrast	Usually not appropriate	◯
CT lower extremity area of interest with IV contrast	Usually not appropriate	Varies
CT lower extremity area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢
US lower extremity area of interest	Usually not appropriate	◯

276

Suspected stress (insufficiency) fracture lower extremity.

Excluding pelvis & hip. Negative XR Next imaging.

Procedure	Appropriateness	Radiation
MRI lower extremity area of interest without IV contrast	Usually appropriate	◯
Repeat X-ray lower extremity area of interest 10-14 days	Usually appropriate	☢
CT lower extremity area of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropraite	☢ ☢ ☢
MRI lower extremity area of interest without & with IV contrast	May be appropriate	◯
CT lower extremity area of interest with IV contrast	Usually not appropriate	Varies
CT lower extremity area of interest without & with IV contrast	Usually not appropriate	Varies
US lower extremity area of interest	Usually not appropriate	◯

277

Follow-up imaging for characterizing nonspecific focal uptake on Te-99m bone scan. Suspected to be a stress fracture.

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
MRI area of interest without Iv contrast	Usually appropriate	◯
MRI area of interest without & with IV contrast	May be appropriate	◯
CT area of interest without IV contrast	May be appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
US area of interest	Usually mot appropriate	◯

278

Suspect stress (fatigue or insufficiency) fracture, pelvis or hip or sacrum. Pregnant patient

Procedure	Appropriateness	Radiation
MRI are of interest without IV contrast	Usually appropriate	◯
XR area of interest	May be appropriate	Varies
MRI area of interest without & with IV contrast	Usually not appropriate	◯
CT area of interest without IV contrast	Usually not appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢
US area of interest	Usually not appropriate	◯

279

Suspect stress (fatigue or insufficiency) fracture of the long bones. Pregnant patient.

Procedure	Appropriateness	Radiation
XR area of interest	Usually appropriate	Varies
MRI are of interest without IV contrast	Usually appropriate	◯
MRI area of interest without and with IV contrast	Usually not appropriate	◯
CT are of interest without IV contrast	Usually not appropriate	Varies
CT area of interest with IV contrast	Usually not appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
US area of interest	Usually not appropriate	◯

280

Back Pain–Child

Variant 1

- Child. Back pain with none of the following clinical red flags: constant pain, night pain, radicular pain, pain lasting >4 weeks, abnormal neurologic examination. Initial imaging evaluation.

Variant 2:

- Child. Back pain with 1 or more of the following clinical red flags: constant pain, night pain, radicular pain, pain lasting >4 weeks, abnormal neurologic examination. Initial imaging evaluation.

Variant 3:

- Child. Back pain with 1 or more of the following clinical red flags: constant pain, night pain, radicular pain, pain lasting >4 weeks, abnormal neurologic examination. Negative radiographs.

Variant 4:

- Child. Back pain with 1 or more of the following clinical red flags: constant pain, night pain, radicular pain, pain lasting >4 weeks, abnormal neurologic examination. Positive radiographs.

Variant 5:

- Child. Chronic back pain associated with overuse. Mechanical back pain.

Variant 6:

- Child. Back pain associated with suspected inflammation, infection, or malignancy.

281

Child.

Back pain with no red flags: constant pain, night pain, radicular pain, pain lasting > 4 weeks, abnormal neurological exam. Initial imaging

Procedure	Appropriateness	Radiation
XR spine are of interest	Usually not appropriate	Varies
MRI complete spine without IV contrast	Usually not appropriate	◯
MRI spine with IV contrast	Usually not appropriate	◯
CT spine area of interest without IV contrast	Usually not appropriate	Varies
CT spine area of interest with IV contrast	Usually not appropriate	Varies
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
Bone scan with SPECT or SPECT/CT	Usually not appropriate	☢☢☢☢
CT myelography complete spine	Usually not appropriate	☢☢☢☢

282

Child.
Back pain with 1 or more red flags: constant pain, night pain, radicular pain, pain lasting > 4 weeks, abnormal neurological exam. Initial imaging.

Procedure	Appropriateness	Radiation
XR spine are of interest	Usually appropriate	Varies
MRI complete spine without & with IV contrast	May be appropriate	◯
MRI spine area of interest without IV contrast	May be appropriate	◯
CT spine area of interest without IV contrast	Usually not appropriate	Varies
Bone scan with SPECT or SPECT/CT	Usually not appropriate	☢ ☢ ☢ ☢
MRI complete spine with IV contrast	Usually not appropriate	◯
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
CT myelography complete spine	Usually not appropriate	☢ ☢ ☢ ☢

283

Child.
Back pain with 1 or more red flags: constant pain, night pain, radicular pain, pain lasting > 4 weeks, abnormal neurological exam. Negative XR.

Procedure	Appropriateness	Radiation
MRI complete spine without IV contrast	Usually appropriate	◯
MRI complete spine without & with IV contrast	May be appropriate	◯
CT spine area of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢ ☢
CT spine area of interest with IV contrast	Usually not appropriate	varies
MRI complete spine with IV contrast	Usually not appropriate	◯
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
CT myelography complete spine	Usually not appropriate	☢ ☢ ☢ ☢

284

Child.
Back pain with 1 or more red flags: constant pain, night pain, radicular pain, pain lasting > 4 weeks, abnormal neurological exam. Positive XR.

Procedure	Appropriateness	Radiation
MRI complete spine without IV contrast	Usually appropriate	◯
MRI complete spine without & with IV contrast	May be appropriate	◯
CT spine area of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢ ☢
CT spine area of interest with IV contrast	Usually not appropriate	varies
MRI complete spine with IV contrast	Usually not appropriate	◯
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
CT myelography complete spine	Usually not appropriate	

285

Child.
Chronic back pain associated with overuse. Mechanical back pain

Procedure	Appropriateness	Radiation
XR spine area of interest	Usually appropriate	Varies
MRI spine area of interest without IV contrast	May be appropriate	◯
CT spine area of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢ ☢
MRI spine area of interest without & with IV contrast	Usually not appropriate	◯
CT spine area of interest with IV contrast	Usually not appropriate	Varies
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
CT myelography complete spine	Usually not appropriate	☢ ☢ ☢ ☢

286

Child.

Back pain associated with inflammation, infection or malignancy

Procedure	Appropriateness	Radiation
MRI complete spine without & with IV contrast	Usually appropriate	◯
XR complete spine	Usually appropriate	☢ ☢ ☢
MRI complete spine without IV contrast	May be appropriate	◯
CT spine are of interest without IV contrast	May be appropriate	Varies
Bone scan whole body with SPECT or SPECT/CT	May be appropriate	☢ ☢ ☢ ☢
MRI complete spine with IV contrast	Usually not appropriate	◯
CT spine area of interest without & with IV contrast	Usually not appropriate	Varies
CT myelography complete spine	Usually not appropriate	☢ ☢ ☢ ☢

287

Diagnostic Imaging Utilization

Clinical indicators for further investigation

Unit 9

288

Utilization of Radiography

"When you have eliminated the impossible, whatever remains, however improbable, must be the truth"

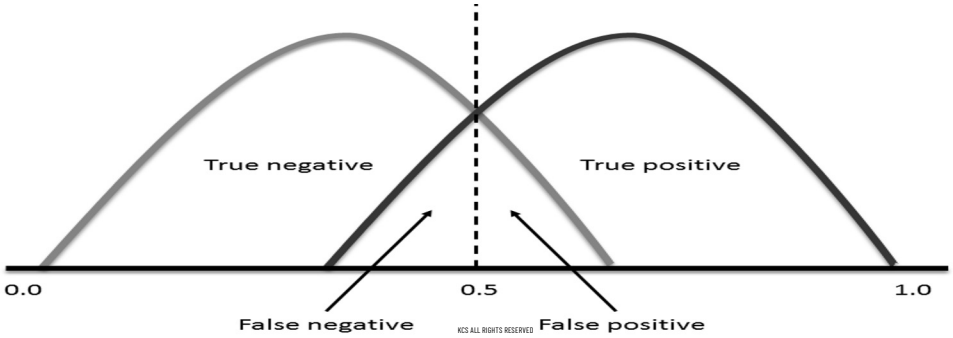
Sherlock Homes (Doyle) 1927

289

Utilization of Radiography

High sensitivity
"SnOut"

High specificity
"SpIN"



290

Clinical indicators for imaging

- Spine fracture
- Spine instability
- Cervical myelopathy
- Cervical radiculopathy
- Cervical facet joint pain
- Thoracic compression fracture
- Spine tumors
- Spine infection
- Lumbar facet joint pain
- Lumbar radiculopathy
- Lumbar spinal stenosis
- Axial spondylitis
- Sacroiliac joint pain
- Cauda equina syndrome
- Stress fractures
- Hip OA
- Hip intra-articular pathology
- Hip impingement
- Knee OA
- Knee fractures
- Knee instability
- Meniscal tears
- Ankle fractures
- Ankle instability
- Ankle impingement
- Foot fractures
- Achilles tears
- Deep venous thrombosis
- Acromio-clavicular joint pain
- Shoulder dislocation/ instability
- Rotator cuff tears
- Shoulder labral tears
- Elbow fracture
- Scaphoid fracture
- Wrist instability

291

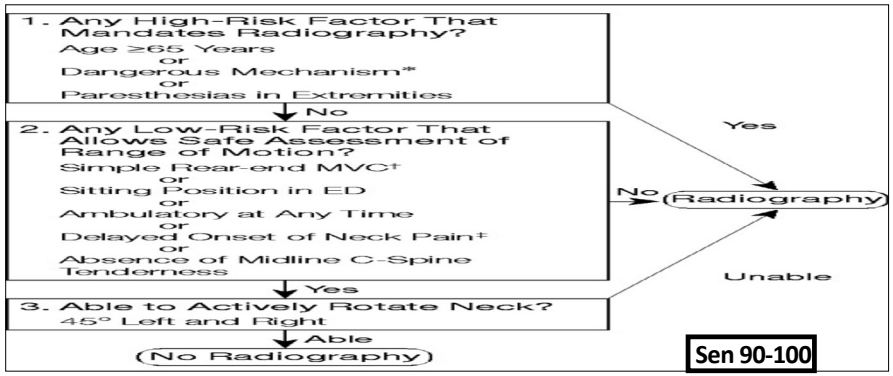
Cranial nerves

#	Nerve	Screen
1	Olfactory	Smell
2	Optic	Vision
3	Oculomotor	Eye movements (up-down, left-right)
4	Trochlear	Eye movements (down & inwards)
5	Trigeminal	Facial sensation
6	Abducens	Eye movements (left-right)
7	Facial	Smile, whistle
8	Vestibulo-chochlear	Hearing
9	Glosso-pharnageal	Posterior tongue sensation
10	Vagus	Heart rate
11	Spinal accessory	Shoulder shrug
12	Hypoglossal	Tongue movement

292

Clinical practice rules

Canadian C-Spine rule



Sen 90-100

Spe 1-77

Stiell 2001

293

Nexus criteria

National Emergency X-Radiography Utilization Study (NEXUS) Criteria

Meets all low-risk criteria?

1. No posterior midline cervical-spine tenderness
2. No evidence of intoxication
3. A normal level of alertness
4. No focal neurologic deficit
5. No painful distracting injuries

YES → **No Radiography**

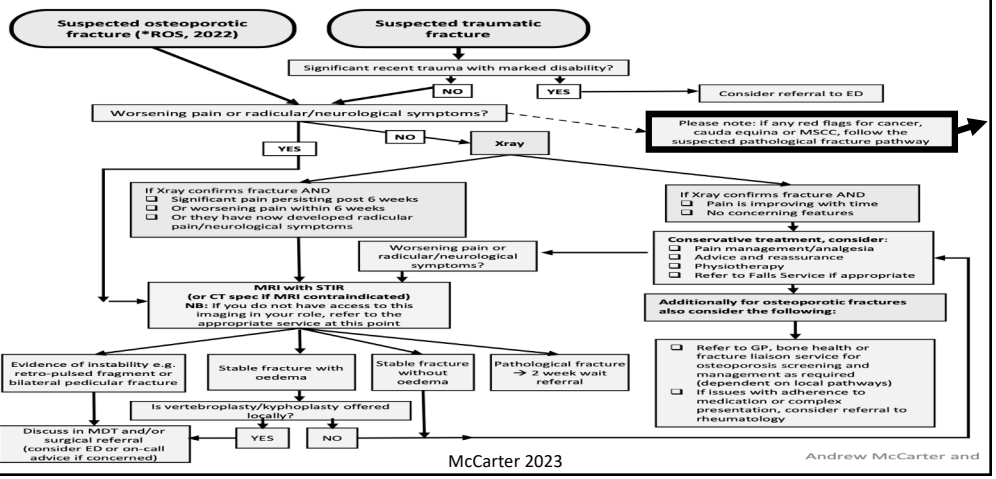
NO → **Radiography**

Sen 99.6

Spec 12.8

294

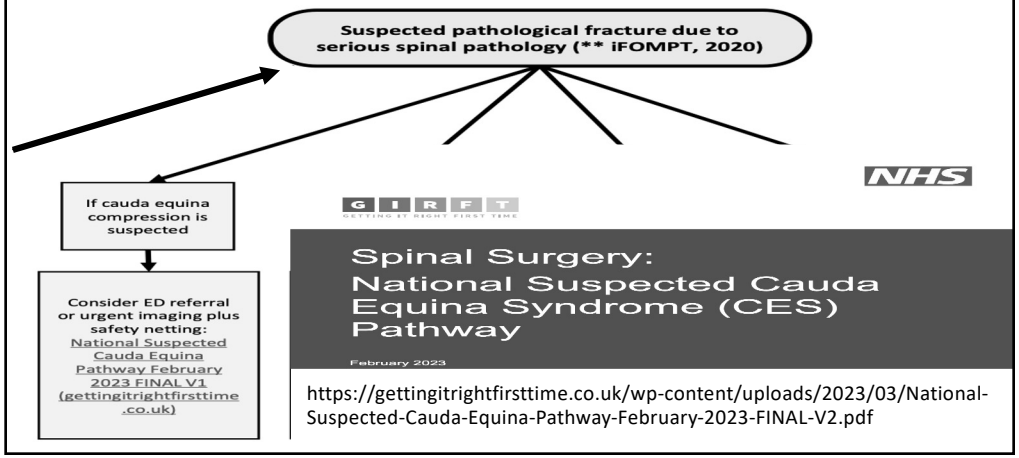
Spine fracture pathway



McCarter 2023

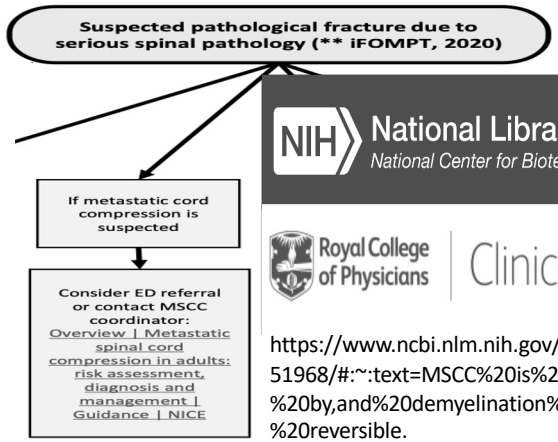
295

Spine fracture pathway



296

Spine fracture pathway



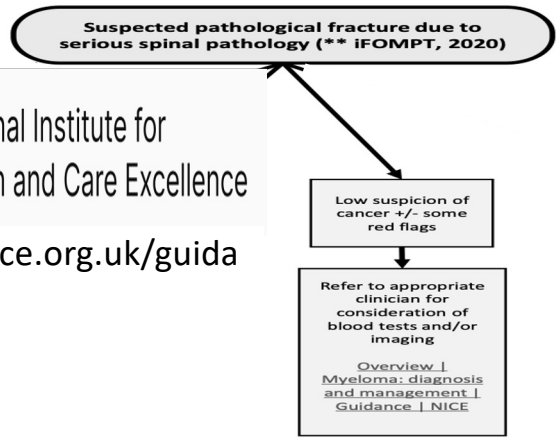
NIH National Library of Medicine
National Center for Biotechnology Information

Royal College of Physicians | Clinical Medicine

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4951968/#:~:text=MSCC%20is%20usually%20caused%20by,and%20demyelination%2C%20which%20are%20reversible.

297

Spine fracture pathway

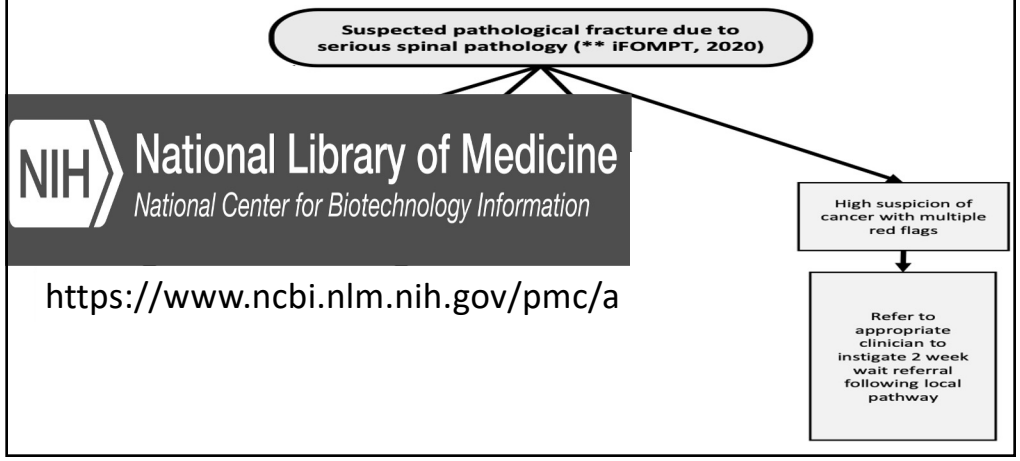


NICE National Institute for Health and Care Excellence

https://www.nice.org.uk/guidance/ng35

298

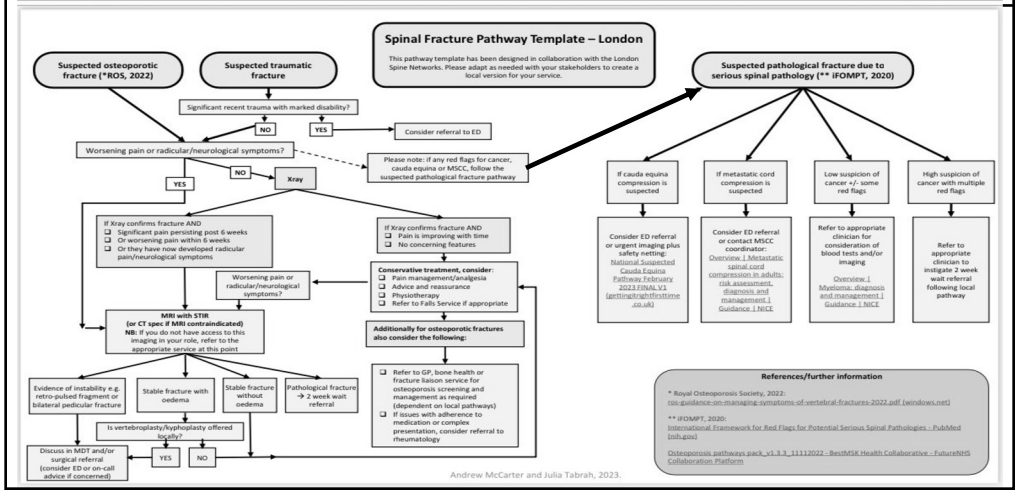
Spine fracture pathway



https://www.ncbi.nlm.nih.gov/pmc/a

299

Spine fracture pathway



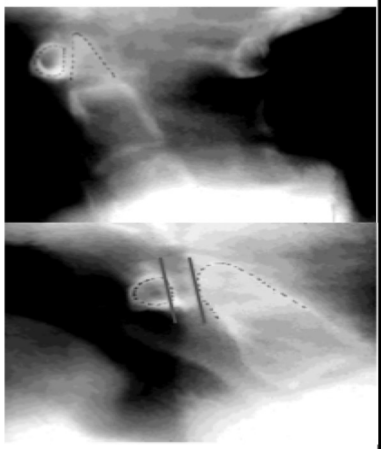
300

Screening for rheumatoid arthritis

Cervical involvement

- Long-standing rheumatoid arthritis or JRA
- May have NO symptoms
- C2-C3 radicular pain in the neck and occiput
- Spinal cord compression
  - Quadriparesis or paraparesis
  - Sphincter dysfunction
  - Sensory deficits
  - TIAs secondary to compromise of the vertebral arteries

Marsh 2023



301

Modified Sharp Purser

Procedure:

- Patient seated with slightly flexed cervical spine
- Examiner stabilizes spinous process of C2 with key grip
- Posterior to anterior translation applied to patient's forehead (do not extend)
- **Positive test:**
- Reproduction of myelopathic type symptoms in flexion
- Reduction with posterior shear force
- Reduction "clunk" heard/felt by patient or examiner

Sens	Spec	+ve LR	-ve LR
69	96	17.3	0.32

Uitvlugt 1988, Cook 2013

302

Alar ligament stability

Procedure:

- Patient seated with neck in slight flexion
- Examiner stabilizes spinous process of C2 with key grip
- Patient's head is side bent or rotated to one side then the other

Positive test:

- Failure to palpate movement of C2 during early stage of movement

Sens	Spec	+ve LR	-ve LR
69	100	Inf.	0.31

Kale 2008, Cook 2013

303

Indications for Cervical MRI

1. Known diagnosis of cancer with suspicion of metastases to the cervical spine, meninges, or spinal cord.
2. Further investigation of spinal abnormality of unknown or uncertain cause seen on plain film.
3. Clinical suspicion of cervical myelopathy or cervical nerve root compression with new onset of extremity weakness, bladder/bowel symptoms, ataxia, spasticity, spinal level sensory loss, etc.
4. Signs/symptoms suggestive of spinal stenosis (weakness, spasticity, clonus, muscle wasting, generalized sensory loss, nerve root compression, hyperactive reflexes, suggestive x-ray findings).
5. To delineate the presence or absence of demyelinating disease.

Lafrank 2019

304

Myelopathy Clinical Prediction Rule

Cook CPR

1. Gait deviation
2. Positive Hoffman's
3. Positive Inverted supinator
4. Positive Babinski
5. Age > 45 yrs.

# +ve	Sens	Spec	+ve LR	-ve LR
1 of 5	94	31	1.4	0.18
2 of 5	39	88	3.3	0.63
3 of 5	19	99	30.9	.081
4 of 5	9	100	Inf.	0.91

Cook 2010, Cook 2013

305

Gait deviation

Procedure:

- Patient requested to walk without aids at normal pace in straight line

Positive test:

- Abnormally wide gait, ataxia spastic gait patterns

Sens	Spec	+ve LR	-ve LR
19	94	3.4	0.85

Cook 2010, Cook 2013

306

Inverted supinator sign

Procedure:

- Reflex hammer used to strike patient's slightly pronated forearm (similar force to testing DTR)

Positive test:

- Finger flexion and/or slight elbow extension

Sens	Spec	+ve LR	-ve LR
51	81	2.68	0.6

Rhee 2009, Cook 2013

307

Hoffman's sign

Procedure:

- Examiner stabilizes middle finger prox. phalanx
- Brisk flexion of DIP by flicking fingernail

Positive test:

- Abduction & opposition of thumb and/or fingers

Sens	Spec	+ve LR	-ve LR
59	84	3.69	0.49

Rhee 2009, Cook 2013

308

Babinski sign

Procedure:

- Foot held in neutral position
- Sharp end of reflex hammer stroked along lateral ½ of sole of foot from heel to metatarsal heads and then across foot to base of great toe

Positive Test:

- Involuntary extension of great toe and abduction of lateral 4 toes

Sens	Spec	+ve LR	-ve LR
7	100	Inf.	0.93

Cook 2010, Cook 2013

309

Clonus

Procedure:

- Examiner stabilizes lower leg
- Foot & ankle briskly pushed and held into dorsiflexion for 5 sec.

Positive test:

- Repeated (min 7 beats) of involuntary ankle plantar-flexion

Sens	Spec	+ve LR	-ve LR
7	99	5.4	0.94

Cook 2010, Cook 2013

310

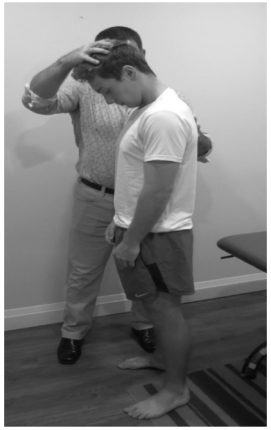
Lhemitte's sign

Procedure:

- Patient asked to flex cervical spine fully
- Lower cervical spine may be targeted by first having the patient protrude neck then flex

Positive test:

- Patient reports electric shock sensations in the midline and/or extremities
- Relief with return to neutral



Sens	Spec	+ve LR	-ve LR
3	97	1	1

Uchihara 1994, Cook 2013

311

Cervical radiculopathy CPR

Wainner CPR

- Cervical rotation <60°
- +ve Spurling's
- +ve Distraction
- +ve ULTT1

Note: +ve ULTT#1 needed to fulfill CPR

# +ve	Sens	Spec	+ve LR	-ve LR
2 of 4	39	56	0.88	1.08
3 of 4	39	94	6.1	0.64
4 of 4	24	99	30.3	0.76

Wainner 2003, Cook 2013

312

Spurling's compression

Procedure:

- Patient neck in neutral flexion/extension side flexion towards affected side symptom increase recorded
- If no increased symptoms, examiner applies combined compression and side flexion
- **Note**: only 3 kg of force applied

Positive test:

- Reproduction of radicular symptoms

Sens	Spec	+ve LR	-ve LR
77.8	77.3	3.4	0.28

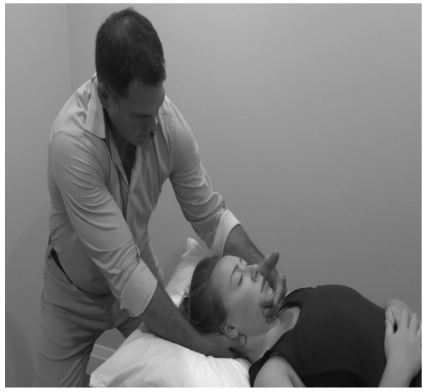
DeHertogh 2007

313

Cervical distraction

Procedure:

- Supine patient with radicular symptoms at present
- Longitudinal traction through pull on occiput & mandible
- **Note:** only 6.3 Kg force applied



Positive test:

- Relief of radicular symptoms

Sens	Spec	+ve LR	-ve LR
44	90	4.4	0.62

Wainner 2003, Cook 2013

314

Upper Limb Tension Test # 1

Procedure:

- Examiner: stabilizes shoulder girdle
- Shoulder abducted to 110°
- Forearm full supination
- Wrist & finger full extension
- Elbow extension

Note: Contralateral cervical side flexion may be added to sensitize procedure further

Positive test:

- Reproduction of radicular pain on elbow extension and/or neck side bend away

Sens	Spec	+ve LR	-ve LR
97	22	1.24	0.14

315

Facet joint pain

Clinical decision rule cervical facet joint pain

Fluoroscopy guided intra-articular facet blocks as the reference standard

- Manual spinal examination
- Palpation for tenderness
- Extension/rotation test

Sens PST 94
MSE 92
-ve LR PST 0.8

Combined PST & MSE & ERT
Spec 84
+ve LR 4.94

Schneider 2014

316

Facet joint pain

Cervical segmental palpation for pain vs imaging

- Prospective study of 121 patients
- Outcome of pain relief when manual examination for segmental pain provocation is used to select spinal level to inject

Yann 2016

	Imaging alone	Palpation for pain
1 day improved	29.7%	44.8%
1 day worse	9.9%	6.9%
1 week improved	21.3%	37.9%
1 week worse	16.9%	10.3%
1 month improved	31.0%	50.0%
1 month worse	22.9%	10.0%

317

CPRs for thoracic compression fracture

Hensche CPR

- Age > 70
- Significant trauma
- Prolonged use of corticosteroids

Sens	Spec	+ve LR	-ve LR
38	100	218	0.62

Roman CPR

- Age > 52
- No presence of leg pain
- BMI < 22
- No regular exercise
- Female

	Sens	Spec	+ve LR	-ve LR
1 of 5	95	34	1.4	0.16
4 of 5	37	96	9.6	0.65

Henschke 2009, Roman 2010, Cook 2013

318

Spine cancer patient history

Back pain patients who:

- Are under 50
- Have no unexplained weight-loss
- Have no past history of cancer
- Respond to conservative care

DO NOT have cancer

Note the necessity of an early trial of conservative care to "**RULE OUT**"

Deyo 1988

Sen 100

319

Spine percussion test

Procedure:

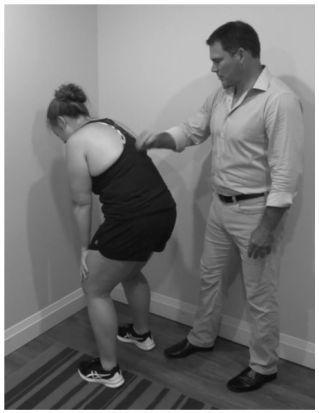
- Firm percussion with closed fist or reflex hammer over spinous processes

Positive test:

- Reproduction of pain

	Sens	Spec	+ve LR	-ve LR
Compression #	87.5	90	8.8	0.14
Metastases	90	89	N/A	N/A
Infection	N/A	N/A	N/A	N/A

Langdon 2010, Abrubiae 2011, Cook 2013



320

Spinal meningitis

Kerning's test

Procedure:

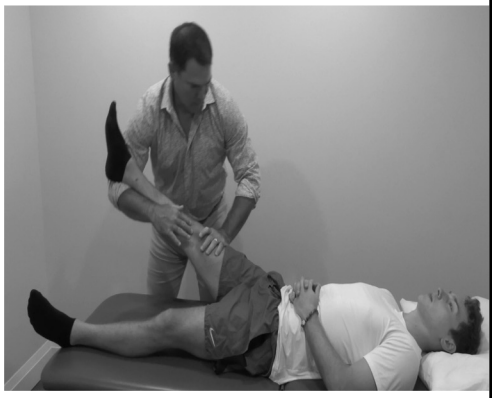
- Supine patient's hip flexed

Positive test

- Inability to tolerate SLR

Sens	Spec
53	85

Thirunavukkarasu 2013



321

Spinal meningitis

Brudzinski's test

Procedure:

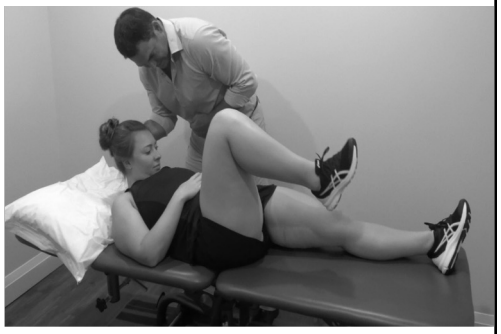
- Supine patient's neck passively flexed

Positive test

- Knee & hip automatically flex

Sens	Spec
66	74

Thirunavukkarasu 2013



322

Lumbar radiography

BMJ guidelines 2023

Do not routinely offer imaging for uncomplicated low back pain

- Less than 5-10% of all back pain is due to a specific spinal pathology
- The remaining 90-95% has no indication of a serious cause and should be managed with conservative treatments.
- Diagnostic triage based on clinical history and examination can help distinguish between non-specific or more serious low back pain
- Imaging may do more harm than good when serious conditions are not suspected and is likely to prolong recovery in patients with non-specific low back pain
- Patient's primary concern of whether their pain is caused by something serious and what they should do to aid recovery can be addressed by sound education and reassurance, without the need for imaging.

Hall 2023

323

American College Radiologists

Lumbar x-rays:

Single most over-requested diagnostic imaging procedure causing;

- Negative economic impact
- Irrelevant findings that lead to inappropriate diagnosis and treatment

ACR 2022

324

Lumbar facet joint pain

Extension-Rotation test

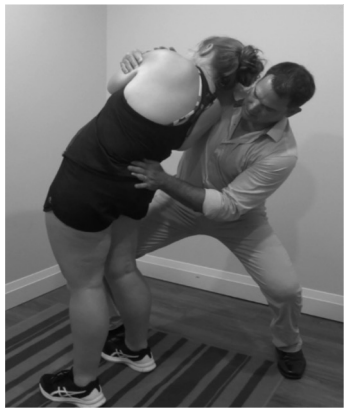
Procedure:

- Combined extension, rotation
- Ipsilateral side bend may also be added

Positive test

- Reproduction of concordant pain

Sens	Spec	+ve LR	-ve LR
100	22	1.28	0



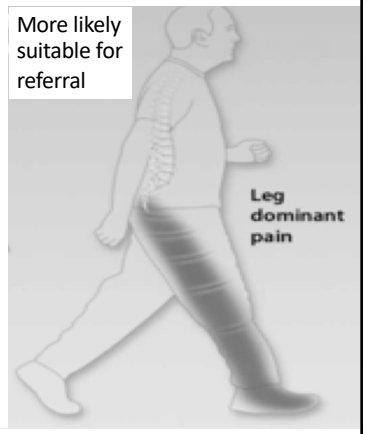
Maitland 1978, Laslett 2006

325

Lumbar radiculopathy

Spine surgeon / APP agreement

Symptoms only	% agree
Untreated constant spine – related **leg pain** for 12 weeks	58%
Treated intermittent spine-related **leg pain** for 12 weeks	70%
Treated constant **leg pain** for 4 weeks	78%
Treated constant spine related **leg pain** for 12 weeks	95%



Rampersaud 2016

326

Lumbar radiculopathy

Spine surgeon / APP agreement

Signs & symptoms	% agree
Untreated constant leg dominant pain of 4 weeks duration with **non-disabling dorsi-flexor weakness**	51%
Treated constant leg dominant pain of 4 weeks duration with **non-disabling dorsi-flexor weakness**	71%
Untreated constant leg dominant pain of 3 months duration with **non-disabling dorsi-flexor weakness**	87%
Treated constant leg dominant pain of 3 months duration **with non-disabling dorsi-flexor weakness**	98%
Constant leg dominant pain of 4 weeks duration with **progressive dorsi-flexor weakness**	98%
Constant leg dominant pain of 3 months duration with **progressive dorsi-flexor weakness**	100%

Rampersaud 2016

327

Lumbar radiculopathy

Neurological testing			
Level	**Myotome**	**Dermatome**	**Reflex**
L2/3	Psoas	Middle antero/Lateral thigh	N/A
L3/4	Quadriceps	Medial epicondyle femur	Patellar
L4	Tibialis anterior	Medial maleolus	N/A
L5	Extensor hallucis longus Gluteus maximus	Dorsum foot	N/A
S1	Gastrocnemius Perponeii	Lateral calcaneus	Achilles

Lauder 2000, Cook 2013

328

Lumbar radiculopathy

Neurological testing

Combinations	Sens	Spec	+ve LR	-ve LR
Sensory & weakness	69	61	1.77	0.51
Sensory & reflexes	14	96	3.5	8.9
Weakness & reflexes	19	96	4.75	0.84
Sensory, weakness & reflexes	12	100	NA	NA

Lauder 2000, Cook 2013

329

Lumbar radiculopathy

Straight leg raise

Procedure:

- Passive elevation of affected leg
- Motion is maintained in sagittal plane with no hip rotation
- Knee in full extension, ankle in neutral

Positive test:

- Reproduction of the typical leg pain

Sens	Spec	+ve LR	-ve LR
96	10	10	0.40

Knuttson 1961

330

Far lateral disc herniation

Procedure:

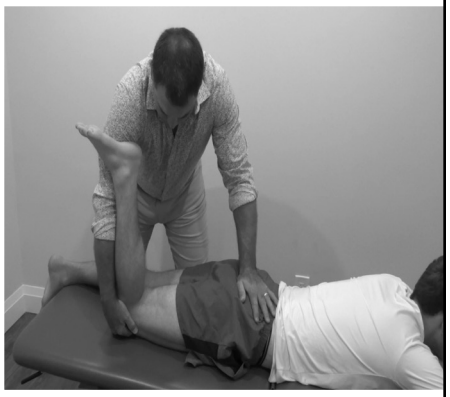
- Examiner stabilizes pelvis & passively flexes the affected knee to the point of first onset of symptoms
- Knee slightly extended to relieve symptoms
- Examiner passively extends hip but not lumbar spine

Positive test:

- Reproduction of typical leg symptoms

Sens
84

Note: Only investigated for far lateral disc herniation not upper lumbar disc herniation



Porchet 1991, Cook 2013

331

CPR for ruling out spinal stenosis

1) Bilateral symptoms
2) Leg pain more than back pain
3) Pain during walking/standing
4) Pain relief upon sitting
5) Age >48 years.

Can <u>rule out</u> stenosis if fail to meet any 1 of the 5

# +ve	Sens	Spec	+ve LR	-ve LR
< 1 of 5	96	20	1.2	0.19
4 of 5	6	98	4.6	0.95

Cook 2010

332

Clinical test for spinal stenosis

Two stage treadmill test

Procedure:

- Patient walks on a level treadmill for up to 10 min.
- 10 min. rest is given in position of comfort
- Patient walks on treadmill elevated to 15^{o} for up to 10 min.

Positive test:

- Worsening of leg pain on level treadmill

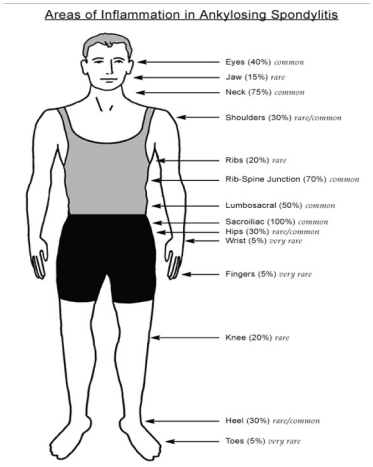
Sens	Spec	+ve LR	-ve LR
50	92.3	6.49	0.54

Fritz 1997, Cook 2013

333

CPR ankylosing spondylitis

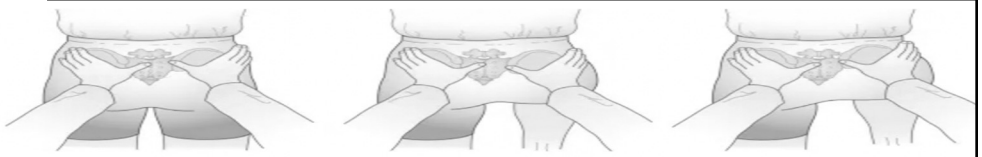
Parameter	Sen	Spec
Response to NSAIDs	77	85
Inflammatory type back pain	75	76
Peripheral arthritis	40	90
Heel pain (Enthesitis)	37	89
Family history	32	95
Iritis/uveitis	22	97
Dactylitis	18	96
Psoriasis	10	96
IBD	4	99



Rudwaleit 2006, Dean 2004

334

Sacroilliac joint clinical tests



KEY POINTS:

1. Sacroiliac joint (SIJ) tests principally; a. Pain provocation, b. joint mobility dysfunction sub-types
2. Systematic review of 12 studies with 547 subjects examining reliability and validity of SIJ mobility dysfunction tests
3. SIJ mobility tests included 8 separate tests as well as clusters of tests
4. Poor validity and reliability of individual tests reported
5. Substantial agreement with clusters of tests but methodological issues identified in these studies
6. Recommendation of removal of these tests from instructional curricula until more fully supported.

Klerks 2020

335

Thigh thrust

Procedure:

- Affected side hip flexed to 90°
- Cupped hand placed under sacrum
- Downwards pressure applied to thigh towards underside hand
- May apply impulse thrust if no initial symptom reproduction

Positive test:

- Reproduction of patient's typical symptoms

Sens	Spec	+ve LR	-ve LR
88	89	8.0	0.13

Gurtke 2009, Laslett 2006

336

Pelvis distraction

Procedure:

- Examiner cups hands over ASIS
- Crossed or straight arm options
- Downwards pressure applied to pelvis for 30 sec.
- May apply impulse thrust if no initial symptom reproduction

Positive test:

- Reproduction of patient's typical symptom

Sens	Spec	+ve LR	-ve LR
50	74	1.9	0.67

Ham 1996, Laslett 2006

337

Pelvis compression

Procedure:

- Patient side lying with painful side up
- Compressive force to lateral pelvis
- Hold for 30 sec.
- May apply impulse thrust if no initial symptom reproduction

Positive test:

- Reproduction of patient's typical symptom

Sens	Spec	+ve LR	-ve LR
69	69	1.2	0.4

Laslett 2005, Cook 2013

338

Sacral thrust

Procedure:

- Anterior pressure applied to midpoint of sacrum
- May be sustained, oscillated or a may apply impulse thrust if no initial symptom reproduction

Positive test:

- Reproduction of patient's typical symptom

Sens	Spec	+ve LR	-ve LR
63	75	2.5	0.49

Laslett 2006

339

Laslett cluster

Laslett cluster

- Thigh thrust
- Distraction
- Compression
- Sacral thrust

Laslett 2003

Thigh thrust: Sn: .88 (Sn**out**)

↓

Distraction: Sp: .81(Sp**in**)

↓

Compression

↕

If compression positive then SIJ confirmed

If compression negative then sacral thrust

Note: Lumbar pathology has been previously ruled out through full McKenzie evaluation

340

Cauda equina syndrome

Saddle anesthesia

Procedure:

- Consent is given (may benefit from a chaperone in the room)
- The sharp handle of a sanitized reflex hammer is used to touch over the lower sacral region
- Patient reports when touch is felt

Positive test:

- Inability to sense light to moderate touch in sacral region

Sens	Spec	+ve LR	-ve LR
38	66	2.0	0.8

Todd 2016, Finucane 2020

Do not say: "Do you feel this?"
Say: "Tell me when I touch your tailbone"

341

Mechanical instability lumbar spine

Passive lumbar extension

Procedure:

- Examiner passively lifts both legs off table to point when lumbar spine in full extension
- Position maintained 30 sec.

Positive test:

- Reports of:
  - low back pain
  - heavy sensation in low back

Sens	Spec	+ve LR	-ve LR
84.2	90.4	8.78	0.17

Kasai 2006

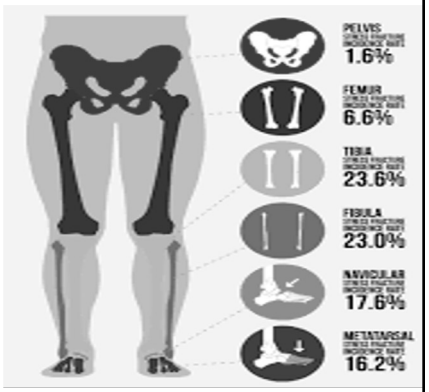
342

Stress fractures

Bone stress injuries in runners risk profile	
Low risk	**High risk**
Postero-medial tibia	Femoral neck
Fibula/lateral malleolus	Anterior cortex tibia Medial malleolus
Femoral shaft	Talus
Pelvis	Navicular
Calcaneus	Proximal diaphysis 5th metatarsal
Diaphysis of 2nd to 4th metatarsals	Base 2nd metatarsal
	Great toe sesamoids

Warden 2014, Wasserstein 2021

Stress fracture incidence



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Stress fracture mechanisms

Bone	**Region**	**Sport**
Scapula	Coracoid process	Trapshooting
Humerus	Diaphysis	Throwing
Ulna	Olecranon	Throwing, Pitching
	Diaphysis	Racquet sports, Gymnastics Weightlifting, Softball Wheelchair sports
Radius	Diaphysis	Gymnastics
Patella	Inferior pole	Running, Hurdling

Hoenig 2022

344

Stress fracture mechanisms

Bone	**Region**	**Sport**
Femur	Neck	Distance running, Jumping, Ballet
	Diaphysis	Distance running
Tarsals	Navicular & cuneiforms	Sprinting, Middle-distance running, Hurdling, Long jump, Triple jump, Football (soccer)
Meta-tarsals	Base of 2nd metatarsal	Running, Basketball, Ballet, Marching Football, Ballet
	5th metatarsal	Basketball, Tennis, Ballet

Hoenig 2022

345

Stress fracture mechanisms

Bone	**Region**	**Sport**
Ribs 1-3		Throwing
Ribs 4-8		Rowing, Kayaking, Golf
Sacrum		Distance Running
Pelvis	Pubic ramus & illium	Distance Running, Ballet
Femur	Neck	Distance Running, Jumping, Ballet
	Diaphysis	Distance running

Hoenig 2022

346

Stress fracture mechanisms

Bone	Region	Sport
Tibia & fibula	Plateaux	Running
	Diaphysis	Running, Basketball, Walking, Ballet
Medial malleolus		Running, Basketball
Talus		Gymnastics
Calcaneus		Distance running, Marching
1st toe & sesamoids		Running, Ballet, Basketball Skating, Soccer

Hoenig 2022

347

Stress fractures

Tuning fork test

Procedure:

- Strike tuning fork
- Gently pass handle of vibrating tuning fork over suspected area of stress fracture

Positive test:

- Reproduction of local pain

Sens	Spec	+ve LR	-ve LR
79.0	63.5	88.0	0.46

Fatima 2012

348

Femoral stress fracture

Fulcrum test

Procedure:

- Patient sitting legs over side of bed
- Clinician provides fulcrum with forearm
- Passive depression of distal femur

Positive test

- Reproduction of concordant pain +/- apprehension

Sens	Spec	+ve LR	-ve LR
100	100	Inf.	0

Johnson 1994, Reiman 2015

349

Hip joint osteoarthritis

Passive range of motion

Procedure:

- Examiner passively moves hip through full available:
  - Flexion, Extension, Internal rotation, External rotation, Abduction

Positive test:

Pain reproduction &/or loss of ROM

# planes	Sens	Spec	+ve LR	-ve LR
1	100	42	1.72	NA
2	81	69	2.61	0.28
3	54	88	4.5	0.52

Birell 2001, Cook 2013

350

Hip joint osteoarthritis

American College Rheumatology criteria

Cluster one:

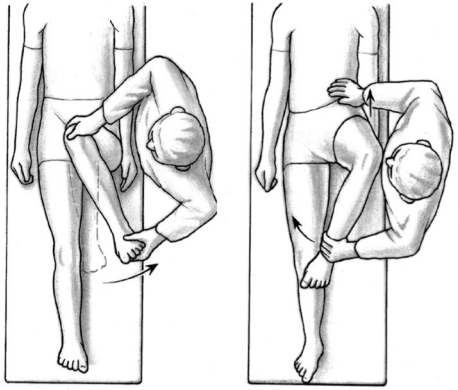
- Hip internal rotation < 15°
- Hip flexion < 115°
- Age > 50 years

Cluster two:

(If Hip internal rotation >/= 15°)

- Pain with hip internal rotation
- Duration of AM stiffness </= 1hr.
- Age > 50 years

	Sens	Spec	+ve LR	-ve LR
Flex < 115°	96	18	1.17	0.22
Int. rot. < 15°	66	72	2.35	0.47



Altman 1991, Cook 2013

351

Hip joint osteoarthritis

CPR for unilateral hip osteoarthritis

1. Self-reported squatting as an aggravating factor
2. Active hip flexion causing lateral hip pain
3. Scour test with adduction causing lateral hip or groin pain
4. Active hip extension causing pain
5. Passive internal rotation of less than 25˚

Sutlive 2008

# variables present	Sens	Spec	+ve LR	-ve LR
>/= 4	0.48	0.98	24.3	0.53
>/= 3	0.71	0.86	5.2	0.33
>/= 2	0.81	0.61	2.1	0.31
>/= 1	0.95	0.18	1.2	0.27

352

Hip joint intra-articular pathology

Flexion abduction external rotation (FABER)

Procedure:

- Examiner places foot on contralateral anterior thigh “Figure 4”
- Pelvis stabilized
- Downward pressure applied to knee to move hip to end of available range

Positive test:

- Reproduction of typical anterior groin pain

Sens	Spec	+ve LR	-ve LR
41	100	Inf.	0.59

Troelsen 2009, Cook 2013

353

Hip joint intra-articular pathology

Thomas test

Procedure:

- Patient supine at edge of bed
- Flex 1 hip to chest
- Allow contralateral leg to lower into extension

Positive test:

- Reproduction of painful click or concordant sign

Sens	Spec	+ve LR	-ve LR
89	92	11.1	0.12

Reiman 2015

354

Femoral-acetabular impingement

Flexion adduction internal rotation (FADIR)

Procedure:

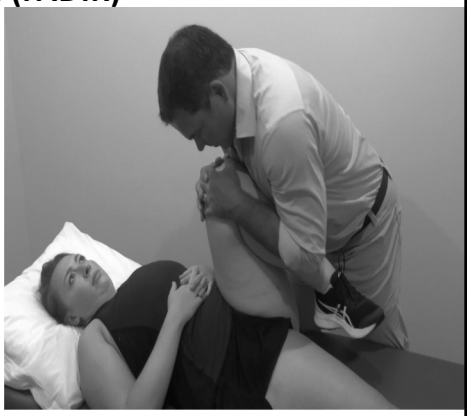
- Examiner passively moves hip into
- 90^{o} flexion then adds in adduction & internal rotation

Positive test:

- Reproduction of typical groin pain

Sens	Spec	+ve LR	-ve LR
59	100	Inf.	0.41

Troelsen 2009, Cook 2013



355

Femoral-acetabular impingement

Impingement provocation test (postero-infero labrum)

Procedure:

- Patient supine, close to edge of bed
- Examiner gently guides hip off side of bed into combined:
  - Extension, abduction, external rotation

Positive test:

- Reproduction of pain &/or apprehension

Sens	Spec	+ve LR	-ve LR
100	0	1.0	NA

Leunig 1997, Cook 2013

356

Knee osteoarthritis

Criteria	NICE	EULAR	ACR
Age	>45 yrs.	>40 yrs.	>50 yrs.
Activity/usage-related pain	All	All	3 or more
No or minimal morning stiffness	All	All	3 or more
Functional limitation	All	All	
Crepitus		1 or more	3 or more
No palpable warmth			3 or more
Bone enlargement		1 or more	3 or more
Bone margin tenderness			3 or more
Restricted ROM		1 or more	
Sensitivity	89	41	51
Specificity	90	49	54

Norris 2018

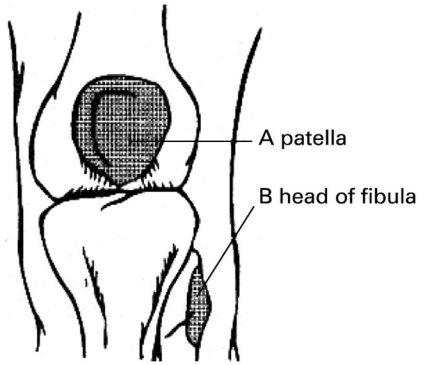
357

Ottawa knee rule

An x-ray is indicated if the patient has any of the following features:

Age > 55 years
Inability to bear weight both immediately and in the emergency department (4 steps) **
Isolated tenderness of the patella*
Tenderness at head of fibula
Inability to flex to 90˚

*No bone tenderness of knee other than patella
**Unable to bear weight twice onto each limb regardless of limping[6]



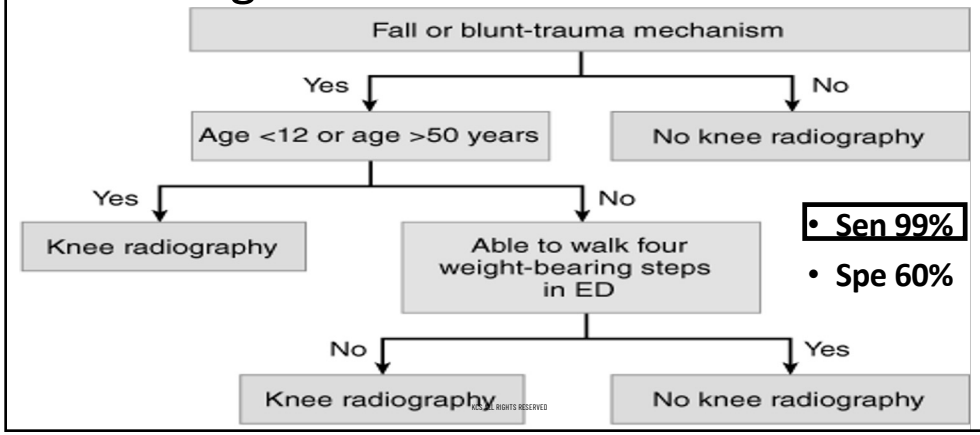
Sen 98.5
Spe 48.6

Bachmann 2004

358

Clinical practice rules

Pittsburg knee rule



- **Sen 99%**
- **Spe 60%**

359

Anterior cruciate ligament tear

Anterior drawer test

Procedure:

- Patient supine with knee flexed to 90^{o}
- Examiner sit on dorsum of patient's foot
- 2 handed grasps of proximal tibia
- Anterior translation force of tibia

Positive test:

- Greater anterior translation of tibia on affected side

Sens	Spec	+ve LR	-ve LR
25	96	6.2	0.78

Noyes 1980, Cook 2013

360

Anterior cruciate ligament tear

Pivot shift test

Procedure:

- Examiner flexes patient's knee to 90º while exerting lateral rotation force to tibia
- Examiner slowly extends knee while changing to a medial tibial rotation force

Positive test:

- Relocation of tibia as knee reaches full extension
- Audible or palpable clunk or click

Sens	Spec	+ve LR	-ve LR
75	100	NA	NA

Jain 2009, Cook 2013

361

Anterior cruciate ligament tear

Lachman's test

Procedure:

- Patient supine knee flexed to 15º
- Examiner stabilizes distal femur with 1 hand
- Other hand grasps proximal tibia
- Anterior translation force applied to tibia

Positive test:

- Greater anterior translation of tibia
- Lack of firm end feel to translation

Sens	Spec	+ve LR	-ve LR
79	100	NA	NA

Jain 2009, Cook 2013

362

Posterior cruciate ligament tear

Posterior Drawer test

Procedure:

- Patient knee flexed to 45°
- Examiner sits on dorsum of foot 2-handed grasp on proximal tibia
- Posterior translation force on tibia in neutral, int. rot & ext. rot.

Positive test:

- Posterior translation of tibia

Sens	Spec	+ve LR	-ve LR
90	99	90	0.1

Grade	Translation
1	0-5 mm
2	6-10 mm
3	11 + mm

Rubenstein 1994, Cook 2013

363

Collateral ligament tear

Valgus stress test (MCL)

Procedure:

- Examiner flexes knee to 30° & stabilizes distal tibia
- Graded medial force applied to lateral aspect of knee
- Repeat test in full knee extension

Positive test:

- Excessive medial joint opening and/or pain
- If +ve only at 30° MCL implicated alone
- If +ve at 30° & 0° ACL/PCL implicated

Valgus	Sens	Spec	+ve LR	-ve LR
Pain	78	67	2.3	0.3
Laxity	91	49	1.8	0.2

Varus stress test (LCL)

Procedure:

- Examiner flexes knee to 30° & stabilizes distal tibia
- Graded lateral force applied to medial aspect of knee
- Repeat test in full knee extension

Positive test:

- Excessive lateral joint opening and/or pain
- If +ve only at 30° MCL implicated alone
- If +ve at 30° & 0° ACL/PCL implicated

Varus	Sens	Spec	+ve LR	-ve LR
Laxity	25	NT	NA	NA

Kastelein 2008, Harilainen 1987, Cook 2013

364

Tibial meniscus tear

Thessaly's 20° "Disco" test

Procedure:

- Examiner holds patient's hands for safety
- Patient flexes knee to 20°
- Rotates trunk & hips fully 3 times each direction

Positive test:

- Joint line pain, locking or catching sensation

	Sens	Spec	+ve LR	-ve LR
Medial	89	97	29.7	0.11
Lateral	92	96	23	0.08

Karachallos 2005, Cook 2013

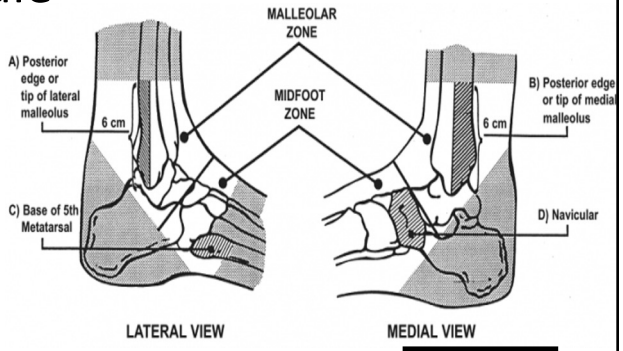
365

Clinical practice rules

Ottawa ankle rule

Ankle X-ray only required if:

- Point tenderness at;
  - Posterior edge (of distal 6 cm) or tip lateral malleolus
  - Posterior edge (of distal 6 cm) or tip medial malleolus
- Inability to weight bear (four steps) immediately after the injury and in emergency department



Sen 90-100
Spe 30-40

Gomes 2022

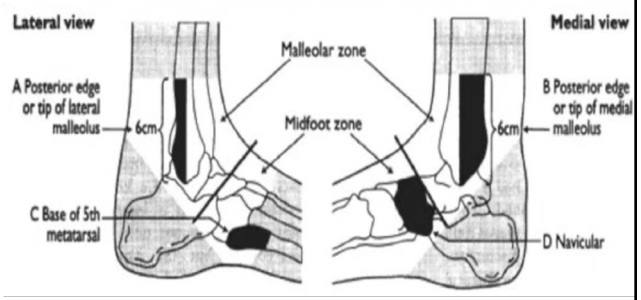
366

Clinical practice rules

Ottawa foot rules

Ankle X-ray only required if:

- Bone tenderness at:
  - Base 5th metatarsal
  - Navicular
- Inability to weight bear in ER



Sen 98
Spe 32

Bachmann 2003, Cook 2013

367

Syndesmosis ankle instability

Fibular translation test

Procedure:

- Examiner stabilizes distal tibia
- Applies a posterior translation force to distal fibula

Positive test:

- Pain &/or increased translation of fibula compared to contralateral side

Sens	Spec	+ve LR	-ve LR
82	88	6.8	0.2

Beumer 2002, Cook 2013

368

Ankle joint instability

Anterior drawer test

Procedure:

- Patient supine with foot off end of bed
- Examiner stabilizes distal tibia
- Anterior translation force to calcaneus

Positive test:

- Increased anterior translation compared to contralateral side

Sens	Spec	+ve LR	-ve LR
100	10	Inf.	Inf.

Phisitkul 2009, Cook 2013

369

Anterior ankle impingement

Forced dorsiflexion test

Procedure:

- Patient seated with knee flexed to 90º
- Examiner stabilizes distal tibia
- Thumb applies inward pressure to lateral aspect of talus
- Forceful passive dorsiflexion of ankle

Positive test:

- Reproduction of typical pain on antero-lateral ankle on dorsiflexion

Sens	Spec	+ve LR	-ve LR
95	88	7.9	0.06

Molloy 2003, Cook 2013

370

Achilles tendon tear

Thompson test

Procedure:

- Patient lies prone foot off end of bed
- Examiner firmly squeezes mid calf muscle belly

Positive test:

- Failure of ankle to involuntarily plantar-flex

Sens	Spec	+ve LR	-ve LR
40	NT	NA	NA

Thompson 1962, Cook 2013

371

Deep vein thrombosus

Clinical sign	Sen	Spec
Calf pressure pain	0.92	0.67
Difference in girth > 1 cm ankle	0.67	0.62
Difference in girth > 1 cm calf	0.92	0.52
Discoloration	0.16	0.86
Homan's sign +ve	0.42	0.97

Fisher 2006

372

DVT upper limb

Criteria	Points
Presence of venous material (catheter, venous access, pacemaker)	1
Unilateral upper extremity pitting edema	1
Localized upper extremity pain	1
Another diagnosis reasonably plausible	-1

# points	Risk category
0	Lower
1	Intermediate
>/= 2	Higher

Sens	Spec	+ve LR	-ve LR
79	64	2.21	0.33

Cook 2013

373

Acromio-clavicular joint

Pain on palpation of AC joint

Procedure:

- Examiner applied graded downward pressure to AC joint line

Positive test:

- Patient reports reproduction of local AC area pain

Sens	Spec	+ve LR	-ve LR
96	10	1.07	0.4

Walton 2004, Cook 2013

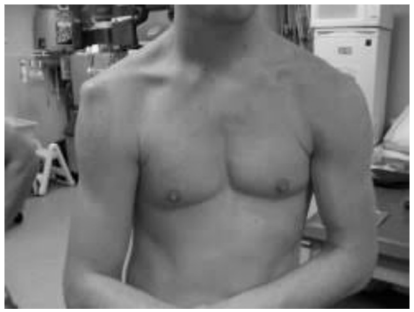
374

Quebec rule for radiography in shoulder dislocation

Quebec Decision rule

Radiographs needed for:

- Age > 40 and humeral ecchymosis
- Age > 40 and 1st dislocation
- Age < 40 and mechanism other than fall from standing height or lower



Sen 100

Emond 2009, Bovardi 2019

375

Shoulder instability

Anterior drawer test

Procedure:

- Examiner stabilizes shoulder girdle
- Passive postero to antero translation of humerus

Positive test:

- Increased anterior translation compared to contralateral

Sens	Spec	+ve LR	-ve LR
28	71	0.97	1.01

Farber2006, Cook 2013

376

Shoulder instability

Apprehension test

Procedure:

- Examiner flexes elbow to 90º, abducts to 45º, externally rotates shoulder to 45º
- Repeat with manual stabilization of anterior humerus

Positive test:

- Patient apprehension of dislocation when not stabilized

Sens	Spec	+ve LR	-ve LR
94	84	5.88	0.07

Bushnell 2008, Cook 2013

377

Rotator cuff tear tests

Empty can full can test

Procedure:

- Patient elevates arms to 90º abduction thumbs up and thumbs down
- Examiner applies downward pressure & notes strength

Positive test:

- More weakness or increased pain in empty than full can position

Sens	Spec	+ve LR	-ve LR
76	39	1.25	0.62

Bak 2010, Cook 2013

378

Rotator cuff tear tests

External rotation lag sign

Procedure:

- Examiner flexes patient's elbow to 90°, flexes to 20° and externally rotates shoulder fully
- Patient asked to maintain position

Positive test:

- Inability to maintain arm in position

Structure	Sens	Spec	+ve LR	-ve LR
Supraspinatus	56	98	28.0	0.45
RC tear	97	93	13.86	0.03
Teres minor	100	93	14.29	0.0

Castoldi 2009, Cook 2013

379

Rotator cuff tear tests

Internal rotation lag sign

Procedure:

- Patient side lying, elbow 90°
- Examiner lifts patient's arm to neutral rotation
- Patient asked to actively keep arm up

Positive test:

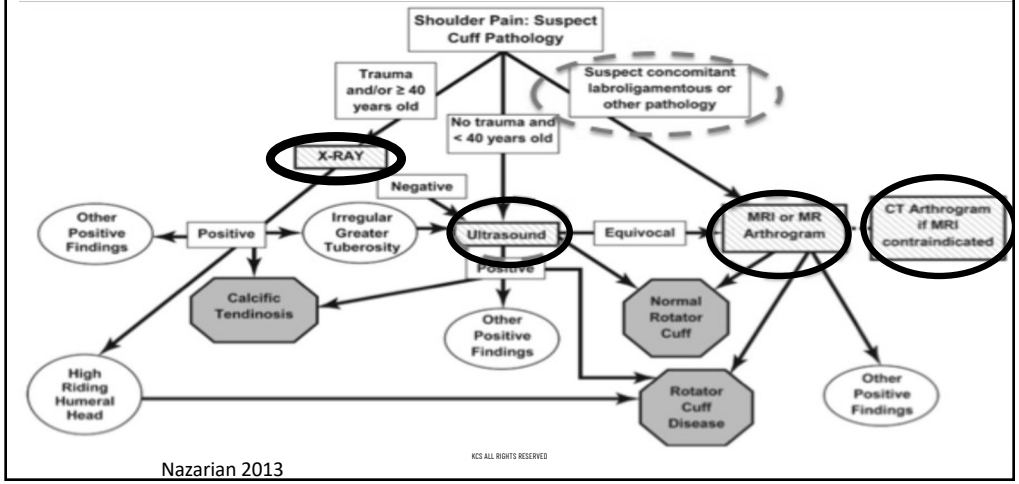
- Inability to keep arm up

Sens	Spec	+ve LR	-ve LR
97	96	24.25	0.03

Hertel 1996, Cook 2013

380

Rotator cuff algorithm



Nazarian 2013

381

Torn labrum

Speed's test

Procedure:

- Patient standing elbow full extension & supination
- Asked to actively flex shoulder from neutral to 60^{o}
- Examiner stabilizes shoulder & provides resistance to flexion

Positive test:

- Reproduction of typical pain

Sens	Spec	+ve LR	-ve LR
32	75	1.28	0.91

Holtby 2004, Cook 2013

382

Torn labrum

Biceps load

Procedure:

- Patient supine, shoulder abducted to 120º, elbow flexed to 90º, forearm in supination, asked to flex elbow against resistance
- Examiner provides resistance to active elbow flexion

Positive test:

- Reproduction of typical pain

Sens	Spec	+ve LR	-ve LR
90	97	26.38	0.11

Kim 2005, Cook 2013

383

Elbow fracture

Elbow flexion test

Procedure:

- Patient lies supine
- Asked to fully flex elbow

Positive test:

- Inability to fully flex elbow compared to contralateral

Sens	Spec	+ve LR	-ve LR
64	100	Inf.	0.36

Darracq 2008,Cook 2013

384

Elbow fracture

Elbow extension test

Procedure:

- Patient sits
- Asked fully extend elbow

Positive test:

- Inability to fully extend elbow compared to contralateral

Sens	Spec	+ve LR	-ve LR
96.8	48.5	1.88	0.06

Applebaum2008 ,Cook 2013

385

Scaphoid fractures CPR's

1. Male gender
2. Sport activity
3. Anatomical snuff box pain on ulnar deviation within 72 hrs of injury
4. Scaphoid tubercle tenderness at 2 weeks

All 4 present

- **91% fracture risk**
- **No fracture if no # 4**

Parvizi 1998, Duckworth 2012

1. Snuff box tenderness
2. Scaphoid tubercle tenderness
3. Pain with longitudinal compression

All 3 absent

Sen 100

386

Wrist instability

Watson test (scaphoid)

Procedure:

- Patient's forearm in slight pronation
- Examiner stabilizes forearm with thumb over volar aspect scaphoid
- Anterior pressure on scaphoid to shift out of alignment
- Wrist passively moved from flexion to extension or ulnar to radial deviation
- Thumb pressure released

Positive test:

- Audible or palpable relocation clunk and pain

Sens	Spec	+ve LR	-ve LR
69	66	2.0	0.47

LaStayo 1995 ,Cook 2013

387

Diagnostic Imaging Utilization

Case studies in imaging

Additional resources

Unit 10

388

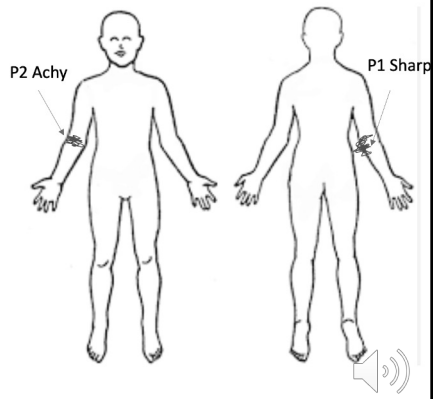
Case Study 1

- 45 y/o Carpenter
  - Mild high blood pressure
  - Smoker
- Five days ago- fell over debris on the worksite and managed to get his right hand out to stop his fall
- Sore right elbow afterward- posterior aspect of the elbow, but he could move it- felt jammed
- He is still working- painful, but able to work
  - Trouble lifting heavy and gripping tools
- Iced the elbow and skipped hockey this week because it was sore
- Comes in to Physiotherapy to see you

389

Upper Extremity Case Study

- On examination
  - Moderately swollen
  - Flexion- mild pain at 110 degrees
  - Missing 10 degrees of Active and Passive extension
    - More painful then flexion
  - Shoulder, wrist ROM is full and pain-free
  - No neck involvement
  - No N&T in his hand
  - TOP anterior and posterior- difficult to isolate
- What are your Differential Dx?



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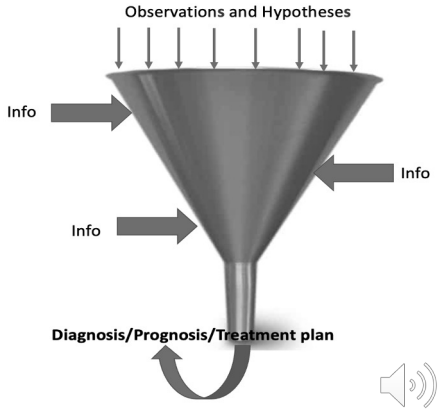
Differential Dx

- Referred pain
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Articular
- Nerve
- Bone
- Bursa
- Associated injuries
- Other

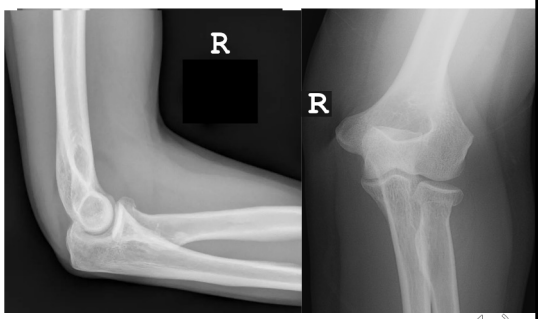


391

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
- 2) Patient has images from a walk-in clinic done earlier today and has brought the images with him
  - What do you see in the images- ABCs? What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?



392

Clinical Reasoning

Four Questions to Answer:

- 3) Do you need more/different imaging?
  - What additional view?
  - What additional image
- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings

Canadian Association of Radiologists
L'Association canadienne des radiologistes

There is no existing guidance from CAR Regarding acute elbow injuries and imaging

393

Clinical Reasoning

Four Questions to Answer:

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg.
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

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Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case # 1 article
- https://boneandjoint.org.uk/Article/10.1302/0301-620X.95B2.29877/pdf

Duckworth 2013

395

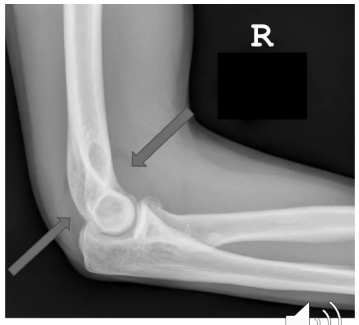
Four Questions

- 1) Yes an X-ray indicated
  - MOI was a trauma- FOOSH with pain afterward
  - Patient was missing elbow extension (Appelboam, 2008)

Elbow extension test to rule out elbow fracture: multicentre, prospective validation and observational study of diagnostic accuracy in adults and children

A Appelboam [1], A D Reuben, J R Benger, F Beech, J Dutson, S Haig, I Higginson, J A Klein, S Le Roux, S S M Saranga, R Taylor, J Vickery, R J Powell, G Lloyd

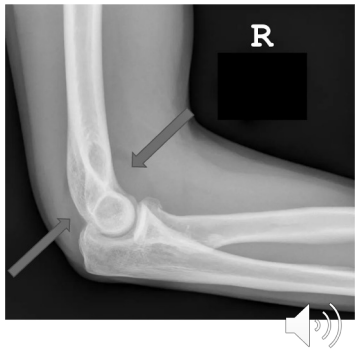
  - Full elbow extension had a negative predictive value for fracture of 98.4% (96.3 to 99.5) in adults and 95.8% (92.6 to 97.8) in children
  - Negative likelihood ratios were 0.03 (0.01 to 0.08) in adults and 0.11 (0.06 to 0.19) in children.



396

Four Questions

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a lateral and an A-P
  - A- film quality is good, R elbow, well centred
  - B- No bone displacement, good joint alignment, no visible fracture lines
  - C- Good joint space indicating no cartilage or crush injury
  - S- Sail signs- you can see the anterior and posterior bursae distention/swelling which is Indicative of an non-displaced radial head fracture in adults (Garmell, 2008)



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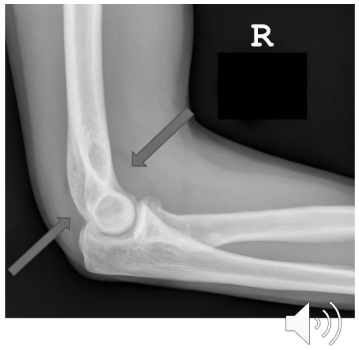
Four Questions

- 3) Imaging is adequate- no additional imaging needed
  - No sinister cause is suspected at this time
- 4) Plan of care is a sling for comfort, referral to fracture clinic
- Fracture looks stable- if fracture clinic agrees then likely
  - Progressive ROM starting immediately
  - Sling for comfort
  - Control activity will help healing

Duckworth, 2013



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Discussion

■ INSTRUCTIONAL REVIEW: TRAUMA

Fractures of the radial head

- Fractures of the radial head account for about 4% of all fractures, > 30% of all fractures involving the elbow and > 50% of all fractures of the proximal forearm
- Equal male/female, with average age of 40 y/o
- 90% are stable. Isolated fractures
- MOI- FOOSH- compression- axial load through forearm

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Discussion

- Fracture types- Stable
  - Most fractures are stable isolated non-displaced or minimally displaced fractures of the neck or the anterolateral portion of the radial head
  - Clinically relevant associated injuries are not seen
    - But incomplete injury to the collateral ligaments and capitellar bone bruises can be identified with MRI.
  - There is documented MRI evidence of ligament injury in over two-thirds of stable fractures of the radial head, but found they did not affect motion or the Mayo Elbow Performance Index

  Kaas, 2011

Fig. 1

Anteroposterior radiograph showing a stable isolated slightly displaced fracture with an articular step, but no gap between the fragments. The fracture was more subtle on the lateral radiograph. The periosteum is probably intact. The only potential adverse outcome of this fracture is possible hindrance of forearm rotation.

400

Discussion

- **Unstable injury patterns**
  - 1) Radial head fracture with posterior dislocation of the elbow
  - 2) Radial head fracture with posterior dislocation of the elbow and fracture of the coronoid process
  - 3) Radial head fracture with rupture of the medial collateral ligament (MCL) or capitellar fracture
  - 4) Radioulnar dissociation (Essex–Lopresti lesion and variants): radial head fracture + rupture of the interosseous ligament + rupture of the triangular fibrocartilage complex (TFCC)
  - 5) Proximal ulnar fracture with fracture of the radial head

401

Discussion

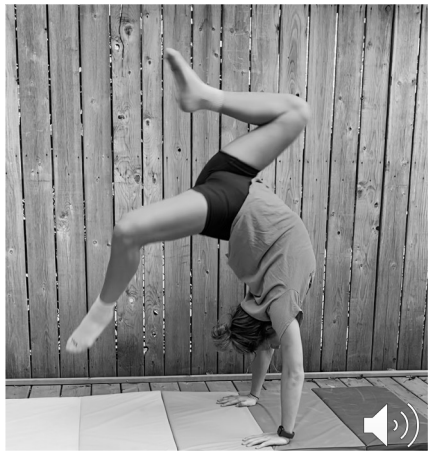
- **Conclusions**
  - Identification of radial head fractures can change the plan of care
  - Referral to the fracture clinic to confirm that the radial head fracture is stable and requires progressive loading supervised by a PT is a standard part of care
  - If the patient develops a rotational block to supination/pronation, a referral back to the fracture clinic may be indicated even if it was identified as a stable fracture

402

Case study 2

Background:

- 15 y/o female
- Competitive gymnast
- Good health otherwise
- Brought in my mother on coach's advice
- No history of trauma
- 2 week onset of acute lumbar pain with beam dismount
- Bilateral lower lumbar aching

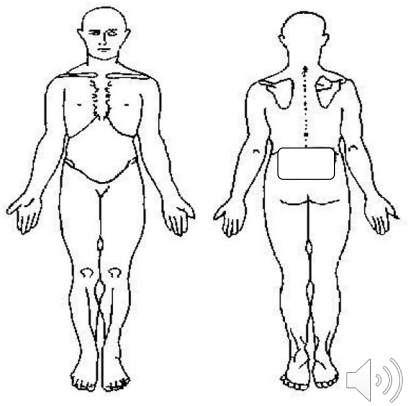


403

Case study 2

Symptoms:

- Bilateral lumbar & upper buttock area pain
- Described as a deep ache, minimal acute pain
- No leg pain, weakness or paresthesias
- Pain behaviour:
  - Intermittent
  - Worse with prolonged stationary standing > sitting
  - Eased by stretching, lying foetal
- Trial of massage with minimal benefit



404

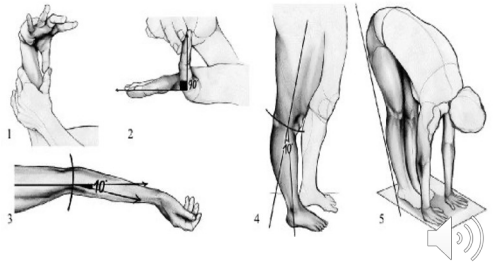
Case study 2

On examination:

- Able to sit through subjective but regularly moves to "stretch her tight back"
- Normal posture, alignment
- Full active pain-free flexion, extension, lateral movements
- Normal neurological, vascular, visceral scanning exam
- 9/9 on Beighton scale

Specific joint laxity	YES	NO
1. Passive apposition of thumb to forearm	☐ Left ☐ Right	☐
2. Passive hyperextension of V-MCP > 90°	☐ Left ☐ Right	☐
3. Active hyperextension of elbow >10°	☐ Left ☐ Right	☐
4. Active hyperextension of knee >10°	☐ Left ☐ Right	☐
5. Ability to flex spine placing palms to floor without bending knees	☐	☐

*Each "YES" is 1 point. A score ≥ 4 out 9 is generally considered an indication of JH. (MCP: metacarpophalangeal).



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Case study 2

Examination cont.

- Reproduction of typical pain with:
  1. Passive lumbar extension
  2. Combined extension/rotation
  3. P-A stress testing L4, L5
- Positive prone instability test

Fritz 2005, Cook 2013, Maitland 1978, Laslett 2006, Kasai 2006

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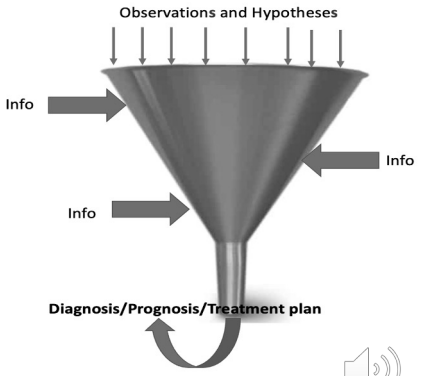
Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other



407

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
- 2) Patient has images from a walk-in clinic done earlier today and has brough the images with him
  - What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?

Acute, subacute or chronic uncomplicated low back pain or radiculopathy. No red flags. No prior management.

Procedure	Appropriateness	Radiation
MRI lumbar spine without IV contrast	Usually not appropriate	○
XR lumbar spine	Usually not appropriate	☢☢☢
CT myelography lumbar spine	Usually not appropriate	☢☢☢☢
Te-99m bone scan with SPECT spine	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
MRI lumbar spine without & with IV contrast	Usually not appropriate	○
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢☢

408

Case study 2

Images from patient

409

Clinical Reasoning

Four Questions to Answer:

- 3) Do you need more/different imaging?
  - What additional view?
  - What additional image
- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings

Acute, subacute or chronic uncomplicated low back pain or radiculopathy. No red flags. No prior management.

Procedure	Appropriateness	Radiation
MRI lumbar spine without IV contrast	Usually not appropriate	○
XR lumbar spine	Usually not appropriate	☢☢☢
CT myelography lumbar spine	Usually not appropriate	☢☢☢☢
Te-99m bone scan with SPECT spine	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually not appropriate	☢☢☢
MRI lumbar spine without & with IV contrast	Usually not appropriate	○
CT lumbar spine without & with IV contrast	Usually not appropriate	☢☢☢

410

Clinical Reasoning

Four Questions to Answer:

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

411

Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case # 2 article (link below) after first answering the questions and then reconsider answers
- https://www.jospt.org/doi/pdf/10.2519/jospt.2005.35.5.319

Thein-Nissenbaum 2005

412

Discussion

Four Questions to Answer:

- 1) Is the X-ray indicated
  - Beam dismount- could be traumatic- yes can be indicated
  - Could have waited 6-8 weeks and rested to see if it would calm down and then X-ray

413

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a lateral and an A-P- reviewing the lateral
  - A- film quality is good, lateral view of low back, well centred
  - B- Grade 1 anteriolithesis L4, possible pars defect of L4 as there is a larger distance between posterior facet joint and anterior vertebral body
  - C- Early degenerative changes at L4-5
  - S- no soft tissue signs
- 3) Imaging is adequate- no additional imaging needed
  - No sinister cause is suspected at this time

414

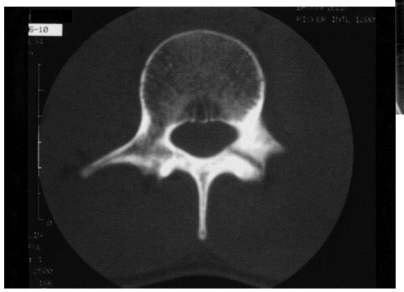
Discussion

- Lytic defect pars of L4
- Grade 1 lysthesis
- Questions:
- Is it bilateral or unilateral?
  - How can you tell?
- Is it acute or long standing?
- How can you tell?

415

Discussion

- Bilateral or unilateral?
  - Oblique view shows one pars at a time
- Is it acute or long standing?
  - Bone edema on MRI



416

Discussion

Is the lysis bilateral or unilateral?

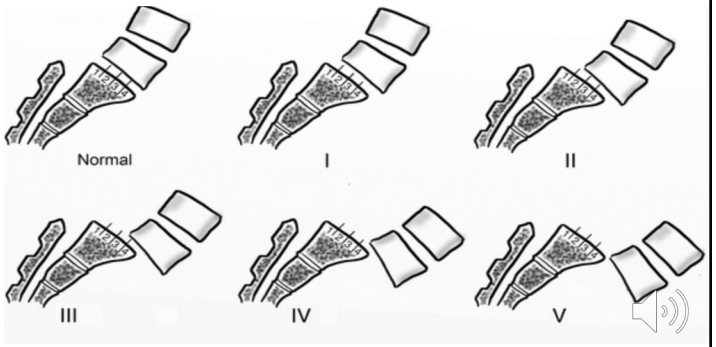
- CT may tell us but significant radiation exposure
- Oblique view shows one pars at a time
- Seen as “the collar on the scotty dog”

417

Discussion

Is the slip progressive?

Worsening spondylolisthesis, which is more common with bilateral pars fracture



Skaggs 2022

418

Discussion

- Repetitive lumbar extension and twisting increase the liability and early progression of lumbar spondylosis
- Up to 47% of young athletes with low back pain have been diagnosed with spondylolysis
- The diagnosis starts with a lumbar spine X-ray
- MRI is the definitive diagnostic tool as it can detect pars edema without exposing athletes to radiation

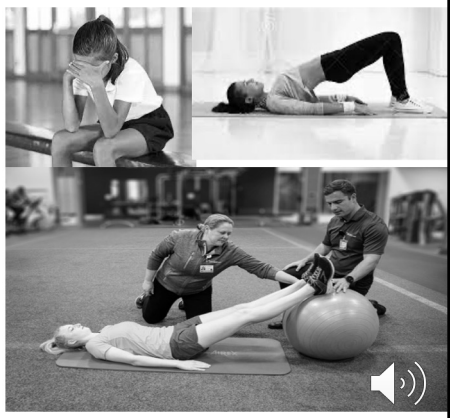
Micheli 2015, Abouhashem 2023

419

Discussion

Four Questions to Answer:

- 4) Plan of Care
  - Education of child, parent, coach
  - Controlled period off sport (2-4 months)
  - Focus on maintaining neutral spine
  - Graduated exercise program and external stabilization
  - Continue to rehab athlete to resolution over 3-6 months or refer back to Sport Med or Specialist if unsuccessful
- Surgery reserved for athletes who do not improve, are unable to return to sport after 6 months



Kalichman 2008, Radcliffe 2009

420

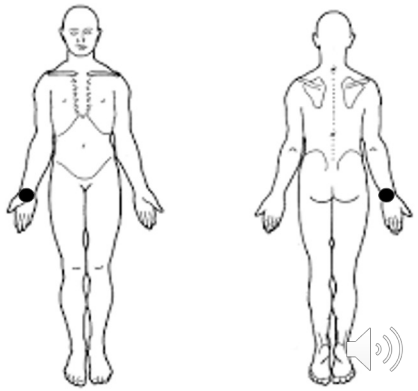
Case Study 3

- 20 y/o University Student working a summer construction job
- 8 week s ago- FOOSH while mountain biking
- X-rays were taken in Emerg. on that day- read as normal

421

Case Study 3

- He continues to have
  - Intermittent right wrist pain
  - Inability to grip- hammer, nail gun
  - Deep ache after 2-4 hours of heavy labour
  - Past Hx- unremarkable
  - General Health is good



422

Case Study 3

Examination

Scanning evaluation

- Full pain free AROM
  - Cervical Spine
  - Shoulder, elbow
  - MCP, PIP, DIP
- Painful loss of wrist extension
- Painful axial loading thumb
- Snuffbox TOP
- Scaphoid Tubercule TOP

Unay 2009, Cook 2013

Painful extension

Sens	Spec	+ve LR	-ve LR
72	60	1.81	0.46

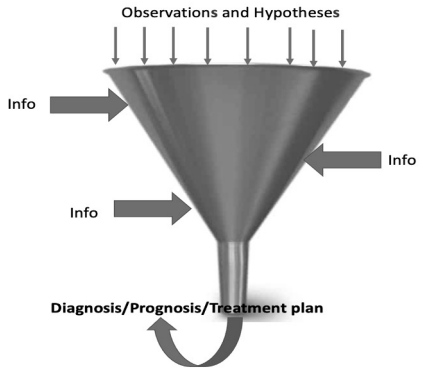
Axial load test

Sens	Spec	+ve LR	-ve LR
72	60	1.81	0.46

423

Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other

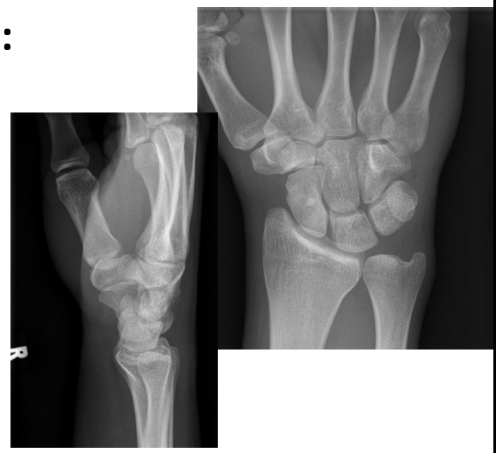


424

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
- 2) Patient has images done 8 weeks ago and has brought the images with him
  - What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?



425

Clinical Reasoning

Four Questions to Answer:

- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings
- 3) Do you need more/different imaging??
  - What additional view?
  - What additional image

Suspect acute hand or wrist trauma. Initial XR negative. Next imaging

Procedure	Appropriateness	Radiation
MRI area of interest without IV contrast	Usually appropriate	○
XR area of interest repeat 10-14 days	Usually appropriate	Varies
CT area of interest without IV contrast	Usually appropriate	Varies
CT area of interest with & with IV contrast	Usually appropriate	Varies
CT area of interest without & with IV contrast	Usually not appropriate	Varies
MRI area of interest without & with IV contrast	Usually not appropriate	○
Bone scan area of interest	Usually not appropriate	☢☢☢
US area of interest	Usually not appropriate	○

426

Clinical Reasoning

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

427

Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case # 3 article (link below) after first answering the questions and then reconsider answers
- https://www.aafp.org/pubs/afp/issues/2004/0901/p879.pdf

Phillips 2004

428

Discussion

Scaphoid fracture CPRs

1. Male gender
2. Sport activity
3. Anatomical snuff box pain on ulnar deviation within 72 hrs. of injury
4. Scaphoid tubercle tenderness at 2 weeks

All 4 present

- **91% fracture risk**
- **No patients had fracture if no # 4**

Duckworth 2012

1. Snuff box tenderness Sp 0.19
2. Scaphoid tubercle tenderness Sp 0.3
3. Longitudinal compression Sp 0.48

All 3 Absent or present

- **Sn 100%**
- **Sp 74%**

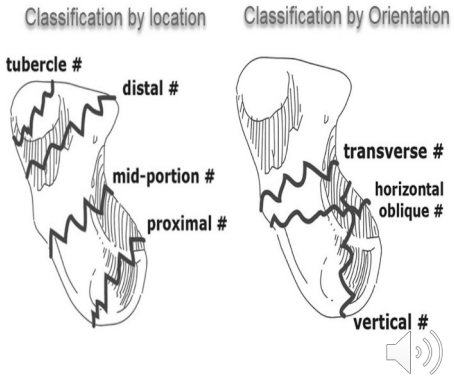
Parvizi 1998

429

Discussion

Carpal fracture incidence

Bone	% fractures
Scaphoid	68.2
Triquetrum	18.3
Trapezium	4.3
Lunate	3.9
Capitate	1.9
Hamate	1.7
Pisiform	1.3
Trapezoid	0.4



430

Discussion

Four Questions to Answer:

- 1)Yes an X-ray was indicated
  - MOI- fall sports
  - TOP scaphoid tubercle and snuff box
  - Decreased wrist extension
  - Patient is male

431

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a P-A and lateral
  - A-images are centred and clear- two views only, normal carpal appearance- no Terry Thomas sign
  - B-No cortical ring sign. No fracture lines in carpal bones
  - C- No disruption to cartilage
  - S- no overt signs of swelling in the snuff box area, no disruption of fat pad

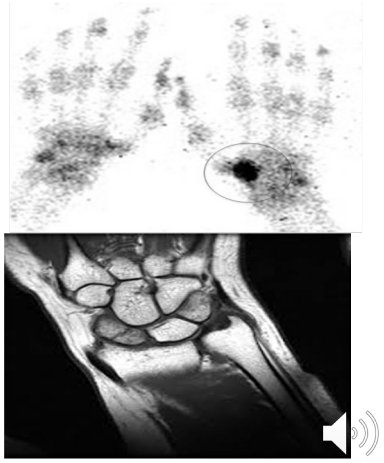
432

Discussion

Scaphoid fractures

Modality	Specificity	Sensitivity
Follow-up X-ray	91.1%	99.8%
Bone scan	97.8%	93.5%
MRI	97.7%	99.8%
CT	85.2%	99.5%

Yin 2012



433

Discussion

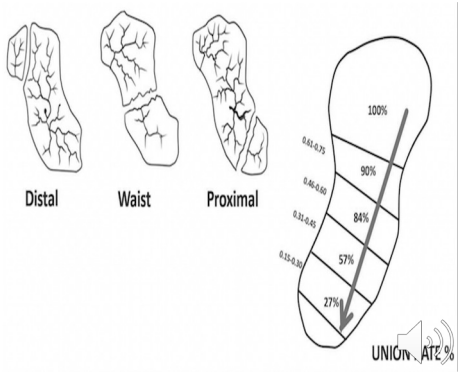
Four Questions to Answer:

- 3) Imaging
  - It has been 8 weeks and assessment of the wrist indicates the need for f/u x-rays- specifically scaphoid views which include
    - PA
    - PA with ulnar deviation
    - Oblique view
    - Lateral view
    - +/- clenched fist (Terry Thomas sign- disruption of scapho-lunate complex)

434

Discussion

Incidence of false negative initial X-ray 5- 48%



435

Discussion

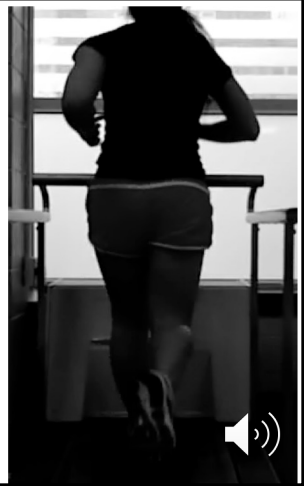
Four Questions to Answer:

- 4) Plan of care is
  - Immobilize/splint short-term
  - Referral to fracture clinic for care
  - Consideration of an ORIF if poor healing over the next 6 weeks as it is a waist fracture

436

Case Study 4

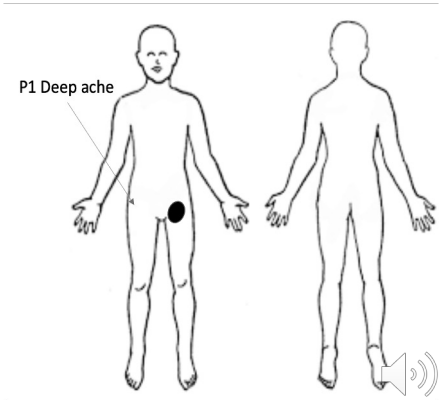
- Background
  - 45 y/o female runner
  - Currently training for her first marathon
  - Started running three years ago to help quit smoking
  - Progressively increasing distance and speed
  - No history of trauma
- Comes into Physiotherapy to see you



437

Case Study 4

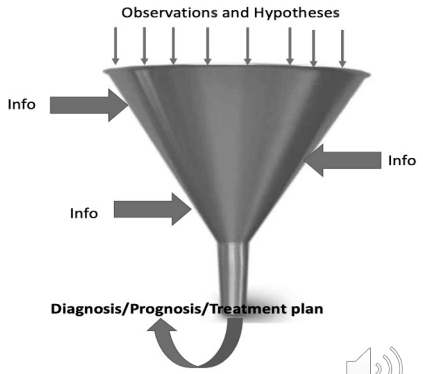
- **Symptoms**
  - Left groin pain
  - Deep Ache
  - Worse with running > 10 km
  - Symptoms last a day and then ease until next run
  - Eased by rest
  - Doing groin stretches from the internet- no benefit



438

Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other



439

Case Study 4

Examination

Normal walking gait

- Full squat
- Full pain-free ROM hip
- Full pain-free muscle contraction
- No pain on palpation
- +ve fulcrum test

Reiman 2008

Fulcrum test

440

Clinical Reasoning

Four Questions to Answer:

- 1) Is an X-ray indicated
  - If yes- why?
  - What might you ask the radiologist to look for?
- 2) Patient has images from a walk-in clinic done earlier today and has brought the images with him
  - What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?

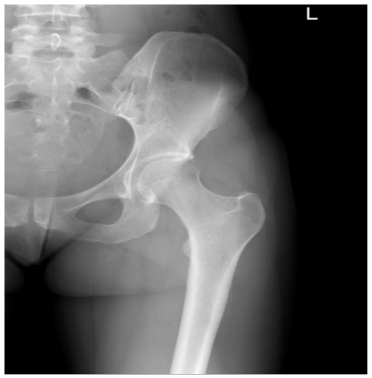
Acute Hip Pain. Fall or minor trauma. Suspected Fracture. Initial imaging

Procedure	Appropriateness	Radiation
XR hip	Usually appropriate	☢ ☢ ☢
XR pelvis	Usually appropriate	☢ ☢
XR pelvis & hip	Usually appropriate	☢ ☢ ☢
CT pelvis & hips with IV contrast	Usually not appropriate	☢ ☢ ☢
CT pelvis & hips without & with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
MRI pelvis & affected hip without & with IV contrast	Usually not appropriate	○
MRI pelvis & affected hip without IV contrast	Usually not appropriate	○
Bone scan hips	Usually not appropriate	☢ ☢ ☢
US hips	Usually not appropriate	○

441

Initial Imaging

Hip A-P



Hip Frog Leg

442

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a A-P and frog leg
  - A- good alignment
  - B- no cortical defects, smooth outline, no calcification in femoral neck
  - C- normal cartilage, good joint space
  - S- no soft tissue issues identified

443

Discussion

Four Questions to Answer:

- 1) Yes- to assess for an insufficiency fracture of the femoral neck
- Risk Factors
  - High-intensity training (increase)
  - Recreational runners
  - Women
  - Poor nutrition/lifestyle activities
  - Lower 25-hydroxyvitamin D
  - Female athlete triad
  - History of smoking

Sens	Spec	+ve LR	-ve LR
100	100	Inf.	0

444

Clinical Reasoning

Four Questions to Answer:

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

445

Clinical Reasoning

Four Questions to Answer:

Acute Hip Pain. Fall or minor trauma. Negative XR. Suspected Fracture. Next imaging

- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings
- 3) Do you need more/different imaging??
  - What additional view?
  - What additional image

Procedure	Appropriateness	Radiation
MRI pelvis & affected hip without IV contrast	Usually appropriate	○
CT pelvis & hips without IV contrast	Usually appropriate	☢ ☢ ☢
CT pelvis & hips with IV contrast	Usually not appropriate	☢ ☢ ☢
CT pelvis & affected hip without & with IV contrast	Usually not appropriate	☢ ☢ ☢ ☢
MRI pelvis & affected hip without & with IV contrast	Usually not appropriate	○
Bone scan hips	Usually not appropriate	☢ ☢ ☢
US hips	Usually not appropriate	○

446

Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case # 1 article (link below) after first answering the questions and then reconsider answers
- https://www.openaccessjournals.com/articles/imaging-of-runninginduced-osseous-injuries.pdf

Sanders 2010

447

Discussion

Four Questions to Answer:

- 3) Imaging is adequate
  - X-ray doesn't show stress fracture but MRI does
  - Relative rest and gradual resumption of activity is likely to be successful
  - May want to look at BMD testing

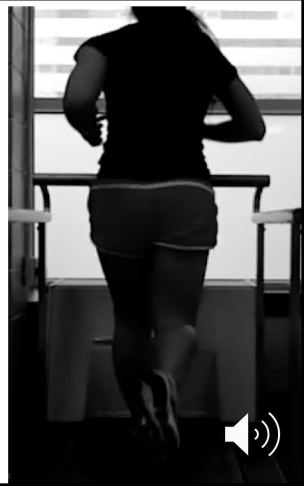
MRI is 100% sensitive

448

Discussion

Four Questions to Answer:

- 4) Plan of care is
  - Walking if pain free (crutches if not)
  - Can get in the pool
  - Upper extremity exercise
  - Graduate return to activity over 3-6 months
  - Refer to fracture clinic (in case of complications further down the track
  - Consider BMD testing, nutritional consult
  - Discuss training elements
  - MRI if poor outcome



449

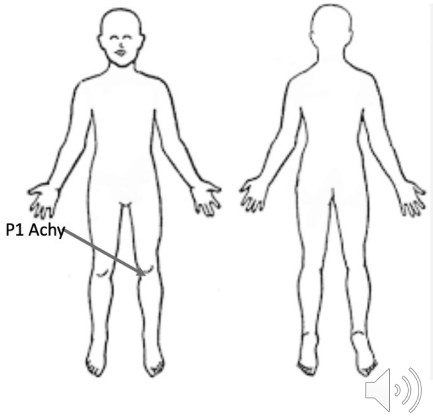
Case study 5

- 62 y/o male office worker was seen in clinic for his acute onset of severe left knee pain
- Started as he was walking downstairs at home one morning 1 week ago
- He works sales and is intermittently active- sometimes plays soccer
- Has been told he has patella femoral pain by his work colleague
- Has come to Physiotherapy to get “fixed”

450

Case 5

- P1- anterior medial knee pain
  - Deep ache
  - Can be sharp with weight-bearing
- Moderate swelling
- Has tried NSAIDs- helps a bit
- Can't sleep well because of pain
- Painful walking- needs a cane



451

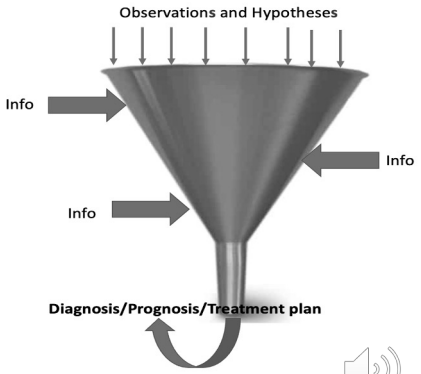
Case 5

- Limited flexion to 90 degrees
  - Missing end range extension
- Flexion painful
- Poor quad activation- secondary to pain
- No ligamentous instability
- Moderate antalgic gait
- TOP anterior medial femoral condyle
  - Less tender medial joint line

452

Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other



453

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
- 2) Patient has images from a walk-in clinic done earlier today and has brought the images with her
  - What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?

454

Clinical Reasoning

Four Questions to Answer:

- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings
- 3) Do you need more/different imaging??
  - What additional view?
  - What additional image

Adult or skeletally mature child.
Fall or acute twisting injury to the knee. No fracture seen on XR. Suspect occult fracture or internal derangement. Next study.

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
CT knee without IV contrast	May be appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

455

Four Questions to Answer:

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

456

Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case article (link below) after first answering the questions and then reconsider answers
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7718131/pdf/main.pdf

Hussain 2020

457

Discussion

Four Questions to Answer:

- 1) Yes- image was indicated

Ottawa knee rules

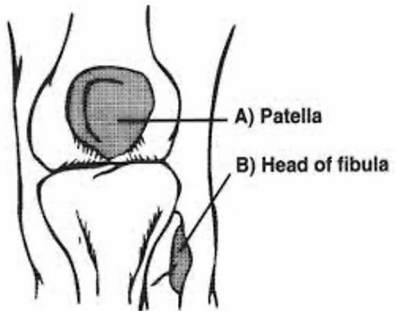
Criteria:

- Age >/= 55 yrs
- Tenderness of the patella
- Inability to flex to 90^{o}
- Inability to take 4 steps in ER

Positive test:

- Any 1 of the 4 criteria is an indication to take an x-ray to rule out a fracture

Jackson 2003 , Cook 2013



Sens	Spec	+ve LR	-ve LR
100	49	1.9	NA

458

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a A-P and lateral
  - A- Good Alignment- tib-fib, patella
    - Evidence of a fabella
  - B- No cortical fracture seen
  - C- joint space present, deformity – crescent shaped medial femoral condyle on both views
  - S-swelling present in lateral view infra-patella

459

Discussion

Four Questions to Answer:

- 3) Imaging is adequate- no additional imaging needed at this time
  - But, if x-ray was negative, possibility of ordering an MRI
  - SONK- spontaneous osteochondral necrosis of the knee
  - Women over the age of 55
  - Can be insufficiency fracture
  - Usually one joint
  - Medial femoral condyle- can be associated with medial meniscal root tear

Adult or skeletally mature child. Fall or acute twisting injury to the knee. No fracture seen on XR. **Suspect occult fracture or internal derangement. Next study.**

Procedure	Appropriateness	Radiation
MRI knee without IV contrast	Usually appropriate	○
CT knee without IV contrast	May be appropriate	☢
Bone scan with SPECT	Usually not appropriate	☢ ☢ ☢
CT knee with IV contrast	Usually not appropriate	☢
MRI knee without IV contrast	Usually not appropriate	○
MRI knee without & with IV contrast	Usually not appropriate	○
US knee	Usually not appropriate	○

460

Discussion

Four Questions to Answer:

- 4) Plan of care
  - Protected Wt-Bearing, assessment and possible treatment for low BMD
  - Consider an unloader brace
  - Referral to fracture clinic
  - If no improvement over 6-8 weeks, consider referral for advanced imaging and consideration of HTO, uni-compartmental knee replacement or other joint preserving intervention

461

Discussion

MRI T1:

- Intermediate to low signal adjacent to fragment
- Variable fragment signal

MRI T2

- High signal line demarcating fragment from bone usually indicates an unstable lesion
- Low signal loose bodies, outlined by high signal fluid
- High signal subchondral cysts

Nicoletti 2023

462

Discussion

- Pathologic lesion affecting articular cartilage and subchondral bone
- Diagnosis may be made radiographically (notch view)
- MRI usually required to determine size and stability of lesion, and to document the degree of cartilage injury.

Anderson 1989, Karadseh 2023

Stage	Evaluation	MRI findings
1	Early	Subchondral bone flattening in the epiphyseal plate before growth plate closure
IIA	Stable	Subchondral cyst present
IIB	Unstable	Incomplete separation of the osteochondral fragment due to repeated trauma
III	Unstable	Fluid around an un-detached, non-displaced osteochondral fragment
IV	Terminal	Complete detachment of osteochondral fragment. Formation of loose bodies

463

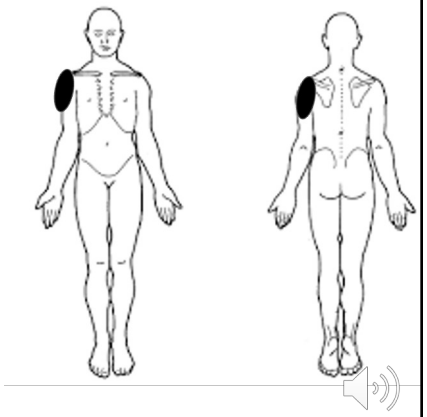
Case study 6

- 85 y/o retired male
- 1 week history of shoulder pain after a slip and fall at home
- Seen in walk in clinic for a bruised shoulder
- Referred to Physiotherapy
- Comes in to Physiotherapy to see you

464

Case 6

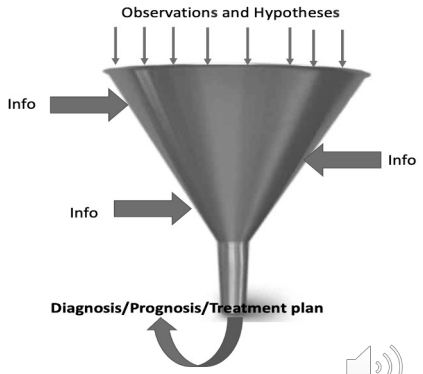
- Constant shoulder pain
- No distal arm pain or paresthesia
- Seen in walk in clinic
- Prescribed NSAIDs and Phyiso
- No imaging ordered
- Aggravated by all shoulder movements and lying on it at night
- Eased with rest in a sling



465

Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other



466

Case 6

Examination

- Normal scanning evaluation of cervical spine, elbow, forearm
- Normal sensory exam upper limb
- Shoulder exam
  - Local shoulder bruising below insertion of deltoid
  - Unable to actively elevate shoulder > 60° (weakness & pain limited)
  - Full passive IR, ER
- Pain palpation more anterior bicipital groove than lateral shoulder
- Unable to perform any "special tests" secondary to apprehension

467

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
  - What might you ask the radiologist to look for?
- 2) You referred him for x-ray next door and he comes back with this image
- What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?

468

Clinical Reasoning

Four Questions to Answer:

- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings
- 3) Do you need more/different imaging??
  - What additional view?
  - What additional image

Traumatic Shoulder Pain
Any etiology Initial imaging

Procedure	Appropriateness	Radiation
XR shoulder	Usually appropriate	☢
CT arthrography shoulder	Usually not appropriate	☢☢☢☢
CT shoulder with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
PET/CT skull base to mid-thigh	Usually not appropriate	☢☢☢☢
MRI arthrography shoulder	Usually not appropriate	○
MRI shoulder without and with IV contrast	Usually not appropriate	○
MRI shoulder without IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢☢☢
US shoulder	Usually not appropriate	○

469

Clinical Reasoning

Four Questions to Answer:

- 4) What will be your plan of care based or the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

470

Case Work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case article (link below) after first answering the questions and then reconsider answers
- https://bmcmusculoskeletdisord.biomedcentral.com/articles/10.1186/s12891-018-2225-1

Longo 2018

471

Discussion

Four Questions to Answer:

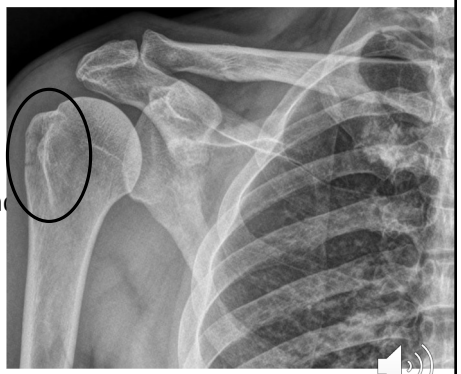
- 1) Yes-
  - Trauma
  - Older patient
  - Bony tenderness
  - Unable to actively or passively move
- May request and ext. rot. view & ask radiologist to specifically look at the greater tuberosity

472

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a A-P shoulder
  - A- shoulder joint is congruent, A-C joint well viewed as well as shoulder blade an ribs
  - B- incongruity of greater tuberosity
  - C- cartilage well preserved
  - S- no unusual dark spots, swelling is tough to pick up on the shoulder



473

Discussion

Four Questions to Answer:

- 3) Imaging is adequate- greater tuberosity can be viewed
  - If there is a Gr Tuberosity fracture, could there also be a cuff tear? (see article)
  - What imaging could be used to identify a cuff tear (see next slide)
  - What if no fracture was evident, would more imaging be needed immediately, or after a period of time
    - Fracture can be occult and more imaging can be indicated

Traumatic Shoulder Pain. Nonlocalized shoulder pain. If negative radiographs- next imaging

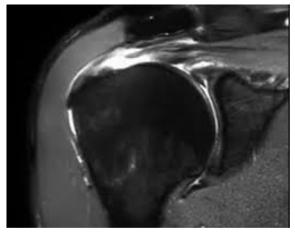
Procedure	Appropriateness	Radiation
MRI shoulder without IV contrast	Usually appropriate	○
CT arthrography shoulder	May be appropriate	☢☢☢☢
MR arthrography shoulder	May be appropriate	○
US shoulder	May be appropriate	○
CT shoulder without IV contrast	Usually not appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually not appropriate	☢☢☢
PET/CT skull to mid-thigh	Usually not appropriate	☢☢☢☢
MRI shoulder without and with IV contrast	Usually not appropriate	○
Bone scan shoulder	Usually not appropriate	☢

474

Discussion

Four Questions to Answer:

- 4) Plan of care
  - Sling to protect
  - Referral to fracture clinic
  - Could be conservative care with non-displaced fracture- gradual loading after a period of immobilization
  - If fracture heals and function continues to be poor- consider further investigating cuff integrity



475

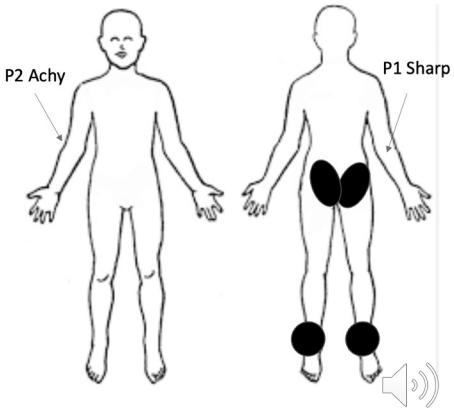
Case study 7

- **Background**
  - 35 y/o female warehouse worker
  - 4 weeks of low back and upper buttock pain
  - She has had episodic low back pain that last 1-3 weeks in the past
  - Currently has a Workers Compensation claim for lifting injury at work
  - Reduced hours and duties
  - Receiving regular spinal manipulation that helps short-term
  - Referred for “core strengthening”

476

Case 7

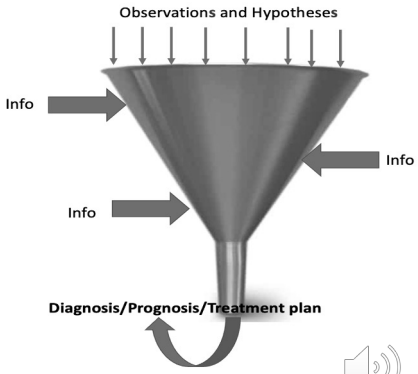
- **Symptoms**
  - Bilateral lumbar spine pain
  - Alternating buttock pain
  - No leg pain or paresthesia
  - Bilateral plantar fasciitis
  - Waking in early morning with pain
  - Morning stiffness for 1 hour that is eased by NSAIDs given by family doctor
  - Increased pain with sitting, eased by walking and yoga



477

Clinical Reasoning

- Referred pain
- Articular
- Discogenic
- Non-contractile soft tissue
- Contractile tissue
- Nerve
- Bone
- Bursa
- Other



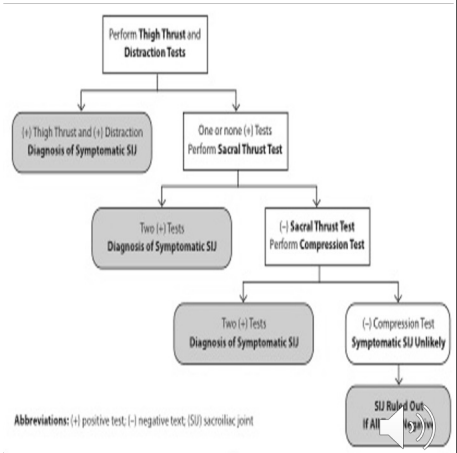
478

Clinical Reasoning

Examination

- Normal gait
- Active ROM limited all directions by lumbar stiffness
- Full pain-free ROM hips
- Normal neurological, vascular, visceral exam
- No directional preference
- Lumbar PA testing positive
- SI provocation tests positive

McKenzie 1981, Laslett 2008

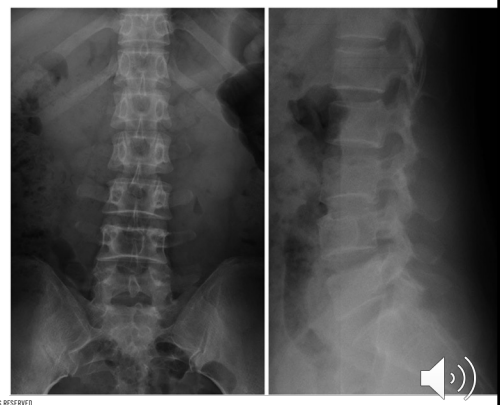


479

Clinical Reasoning

Four Questions to Answer:

- 1) Was an X-ray indicated
  - If yes- why?
- 2) Patient has images from her chiropractor and has brought the images with him
  - What do you see in the images? Consider A,B,C s
  - What would you do in your practice context? Consult a colleague, consult a Physician colleague? Perform an intervention and reassess?

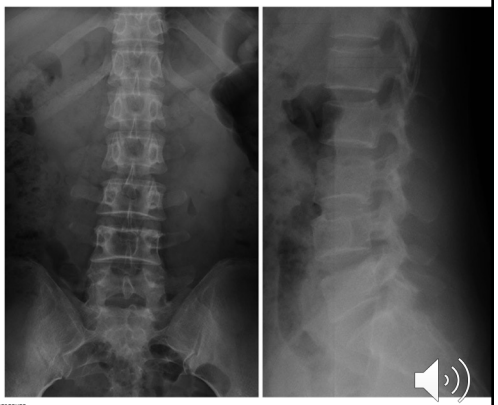


480

Clinical Reasoning

Four Questions to Answer:

- Considering
  - Age
  - Onset
  - MOI
  - Symptom Behaviour
  - Exam findings
- 3) Do you need more/different imaging??
  - What additional view?
  - What additional image



481

Clinical Reasoning

Four Questions to Answer:

- 4) What will be your plan of care based on the information that you have at this time:
  - Load/unload
  - Modalities
  - Rehabilitate with PT in charge
  - Refer to Emerg.
  - Refer to a specialist with what advice
  - Refer to another provider with what advice

482

Case work

- Answer the four questions
- In the plan of care consider your treatment environment and discuss what you would actually have to do
- Consider rehab options short to medium term
- Read the Case article (link below) after first answering the questions and then reconsider answers
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3403247/pdf/10.1177_1759720X11436240.pdf

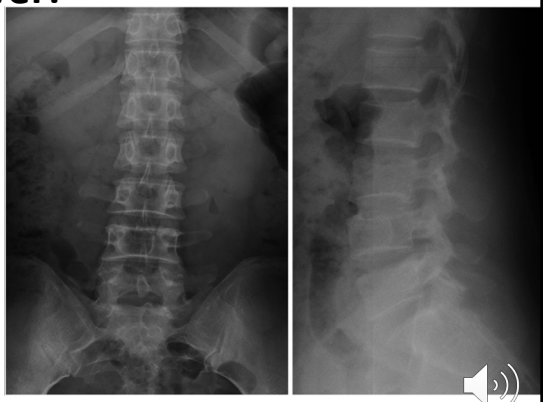
Ostergaard 2012

483

Discussion

Four Questions to Answer:

- 1) Yes- to help identify inflammatory subchondral erosion, sclerosis and joint fusion of the SIJ
  - Early stages of the disease- radiographs can appear normal
  - Later stages may demonstrate SI erosion, sclerosis, fusion

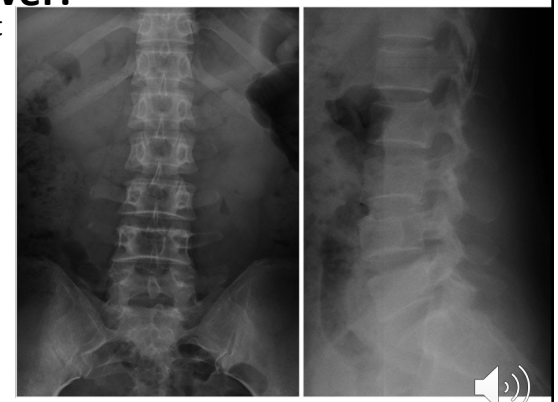


484

Discussion

Four Questions to Answer:

- 2) Description of your work context and what you would do with the radiographs
  - Radiographs
  - Views are a
  - A- alignment is normal, good lordosis, 5 lumbar vertebrae
  - B- No compression fracture, no bony bridging
  - C- Good disc space between Lx vertebrae, early SIJ joint fusion
  - S- unremarkable



485

Discussion

Four Questions to Answer:

- 3) Imaging is adequate- likely consider an A-P SIJ view
- 4) Plan of care
  - Order blood tests
    - HLBA -27
    - CRP
    - ESR
- Referral to Rheumatology- who may order an MRI or a Bone Scan- better for viewing active inflammatory reaction

486

Discussion

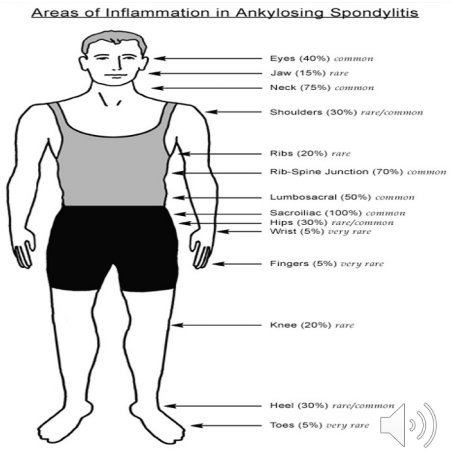
Axial spondylitis

1. Morning stiffness > 30 min. duration
2. Improvement in back pain with exercise but not rest
3. Awakening because of back pain in second ½ of night only
4. Alternating buttock pain

If 3 or more present

+ve LR = 12.4

Rudwaleit 2006, Dean 2004



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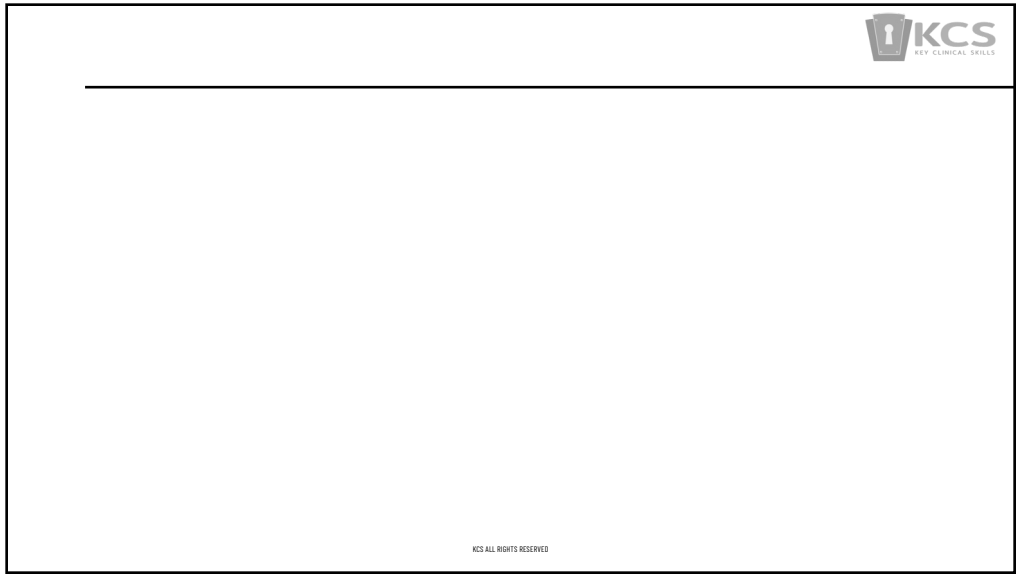
488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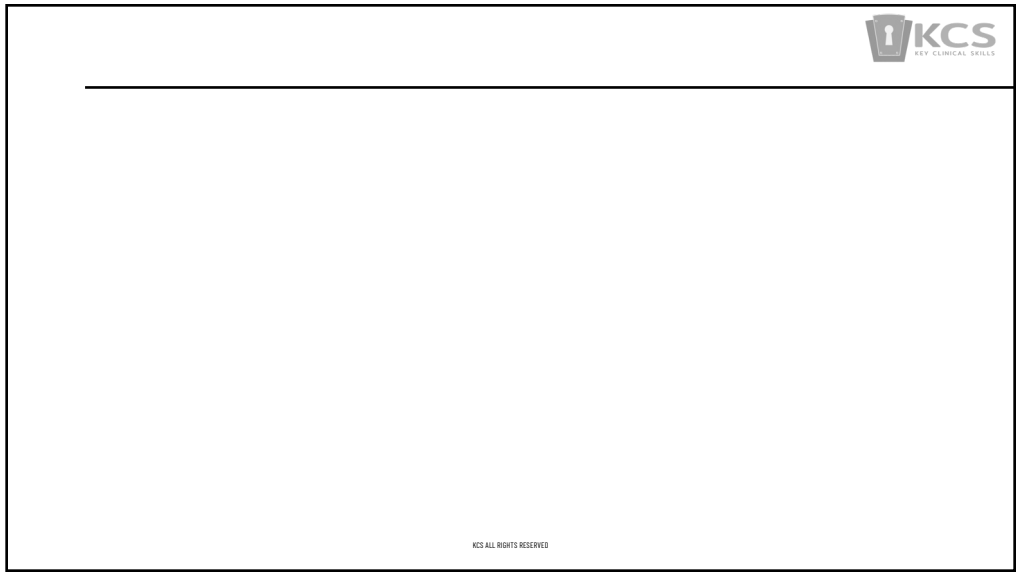
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490

Conventional Radiography

Decision making considerations	Advantages	Disadvantages	Primary utilization	Variations
First-order diagnostic imaging modality Need at least 2 views at 90 deg.	Low cost Widespread availability Produces excellent skeletal images	Uses ionizing radiation Often over utilized Less sensitive to subtle pathology	Screening for & visualization of pathology of bone and joints (fractures, dislocations, neoplasms, arthritis) Monitoring fracture healing Visualization of orthopaedic hardware	Fluoroscopy Arthrography Myelography Discography

491

Computed Tomography

Decision making considerations	Advantages	Disadvantages	Primary utilization	Variations
Usually follows X Ray to confirm a Dx or further define pathology	Better contrast resolution Provides multi-planar images Shorter scan time than MR Allows thinner slices than MR	More expensive than X-ray Radiation dose greater than X-ray Inferior soft tissue characteriza-tion	Defining complex or subtle fractures Evaluating soft tissue and especially bone tumors	CT-Angiography CT-Myelography

492

Magnetic Resonance Imaging

Decision making considerations	Advantages	Disadvantages	Primary utilization	Variations
The imaging sequence determines which tissues or diseases are preferentially displayed T1 shows fat & provides good anatomical detail T2 shows free water	Excellent soft-tissue contrast Does not use ionizing radiation	Claustrophobia Imaging of bone inferior to CT Contra-indicated with pacemakers & aneurysm clips	Identifying & characterizing soft tissue injuries Characterization of hematomas & joint effusions Identifying bone edema and marrow channels Evaluating bone & soft tissue tumors	MR with contrast MR-arthrography

493

Bone Scan

Decision making considerations	Advantages	Disadvantages	Primary uses	Variations
May be used to detect fractures or bony lesions when other imaging modalities are normal	Highly sensitive modality	Low specificity Somewhat invasive	Localized bone tumors Skeletal metastases Early diagnosis of stress fractures	Technetium 99m typical tracer used but others available in special circumstances

494

Diagnostic Ultrasound

Decision making considerations	Advantages	Disadvantages	Primary uses	Variations
May substitute for MR in evaluating MSK soft tissues	Does not use ionizing radiation Less expensive than MR Allows real-time visualization of structures during movement	Highly dependent on technical skill of ultra-songrapher	Identify rotator cuff lesions Evaluating various tendon injuries Evaluating infant hip for developmental dysplasia	Doppler

495

Utilization of spine MRI/CT/US

Diagnosis	CT	MRI	U/S
Osseous pathology	Fractures, loose fragments Boney tumors	Tumors Infections	
Radiculopathy	Osseous narrowing of spinal canal and IVF	Nuclear herniation vs annular prolapse Other causes ie. facet, cysts, tumors infection	
Degenerative changes	Facet joint degeneration & osteophytosis	Intra-discal degeneration, RA	
Functional application		Dimensions of canal in various positions Fatty infiltrates of muscle	Pre-manipulative testing of VA Measurement of muscle size Trunk muscle recruitment

496

Utilization of spine MRI/CT/US

Diagnosis	CT	MRI	U/S
Osseous pathology	Complex fractures Intra-articular fragments at shoulder & elbow	AVN humeral head AVN scaphoid	
Tendon injury		Rotator cuff tendinitis vs partial tear vs full tear	Rotator cuff tendinitis vs partial tear vs full tear AC joint injury
Ligament injury		Instability of shoulder Labral tears Ligamentous lesions wrist	Ligament strain elbow on stress tests Tenosynovisits and ganglia
Nerve entrapment	Dimensions of carpal tunnel		Flattening of median nerve in carpal tunnel

497

Utilization of spine MRI/CT/US

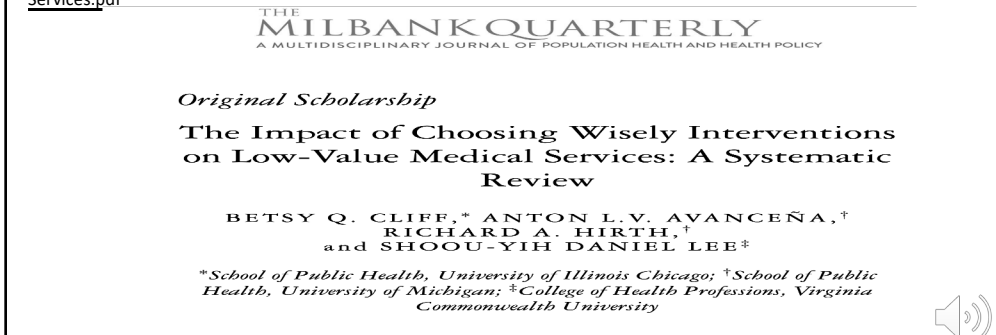
Diagnosis	CT	MRI	U/S
Osseous pathology	Complex fractures hip, knee, ankle	Occult fractures & tumors Osteochondral fractures Osteochondritis dissecans Early AVN hip Stress fractures Epiphyseal fractures	
Pediatrics		Congenital dislocation hip	Congenital dislocations of hip
Ligament injury		Meniscal tears Best modality for tears of ACL PCL	Capsular & ligament tears knee, ankle
Tendon injury		Tendinitis, thickening, increased fluid	Tendinitis, partial & full tears

498

Additional reading

These articles are all open access and recommended reading for further study

https://vbidhealth.com/wp-content/uploads/2021/09/The-Impact-of-Choosing-Wisely-Interventions-on-LVC-Medical-Services.pdf


THE MILBANK QUARTERLY
A MULTIDISCIPLINARY JOURNAL OF POPULATION HEALTH AND HEALTH POLICY

Original Scholarship

The Impact of Choosing Wisely Interventions on Low-Value Medical Services: A Systematic Review

BETSY Q. CLIFF,* ANTON L.V. AVANCEÑA,† RICHARD A. HIRTH,† and SHOOU-YIH DANIEL LEE‡

*School of Public Health, University of Illinois Chicago; †School of Public Health, University of Michigan; ‡College of Health Professions, Virginia Commonwealth University

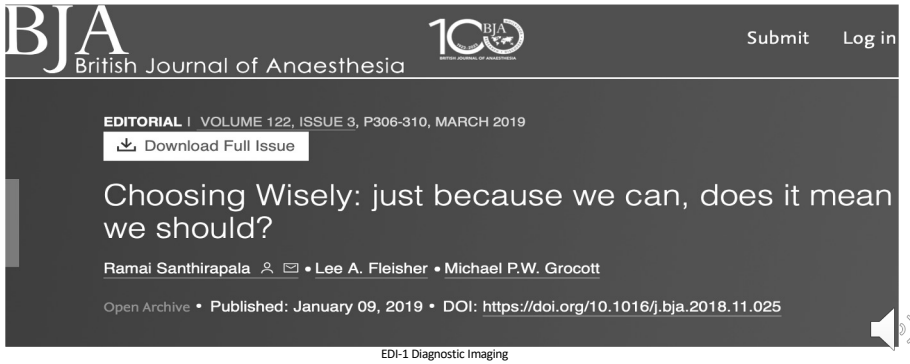
EDI-1 Diagnostic Imaging

499

Additional reading

These articles are all open access and recommended reading for further study

https://www.bjanaesthesia.org/article/S0007-0912(18)31350-3/fulltext


BJA British Journal of Anaesthesia

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EDITORIAL | VOLUME 122, ISSUE 3, P306-310, MARCH 2019

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Choosing Wisely: just because we can, does it mean we should?

Ramai Santhirapala • Lee A. Fleisher • Michael P.W. Grocott

Open Archive • Published: January 09, 2019 • DOI: https://doi.org/10.1016/j.bja.2018.11.025

EDI-1 Diagnostic Imaging

500

Additional reading

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These articles are all open access and recommended reading for further study

https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2779118

Original Investigation | Health Policy

April 27, 2021

Assessment of Overuse of Medical Tests and Treatments at US Hospitals Using Medicare Claims

Kelsey Chalmers, PhD[1,2]; Paula Smith, MPH[1]; Judith Garber, MPP[1]; et al

» Author Affiliations | Article Information

JAMA Netw Open. 2021;4(4):e218075. doi:10.1001/jamanetworkopen.2021.8075

501

Additional reading

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https://onlinelibrary.wiley.com/doi/pdf/10.1002/jmri.23530

JOURNAL OF MAGNETIC RESONANCE IMAGING 35:512–517 (2012)

Review

Radiology's Ethical Responsibility for Healthcare Reform: Tempering the Overutilization of Medical Imaging and Trimming Down a Heavyweight

Diane Armao, MD,[1,2] Richard C. Semelka, MD,[1*] and Jorge Elias Jr, MD, PhD[3]

502

Additional reading

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http://www.columbia.edu/~djb3/papers/jama1.pdf

Radiation Exposure From Medical Imaging
Time to Regulate?

David J. Brenner, PhD
Hedvig Hricak, MD

503

Additional reading

KEY CLINICAL SKILLS

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https://bjsm.bmj.com/content/bjsports/53/23/1447.full.pdf

Consensus stateme

OPEN ACCESS

Imaging with ultrasound in physical therapy: What is the PT's scope of practice? A competency-based educational model and training recommendations

Jackie L Whittaker [1], Richard Ellis,[2] Paul William Hodges [3], Cliona OSullivan,[4] Julie Hides,[5] Samuel Fernandez-Carnero,[6] Jose Luis Arias-Buria,[7] Deydre S Teyhen,[8] Maria J Stokes[9]

504

Additional reading

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https://www.sciencedirect.com/science/article/pii/S2468781217301819

Musculoskeletal Science and Practice
Volume 34, April 2018, Pages 27-37

Original article

Exploring the clinical use of ultrasound imaging: A survey of physiotherapists in New Zealand

In Memoriam: *Rachael De Jong (1996–2017)*: This paper is dedicated to the memory of Rachael. A very bright star, taken too soon. The world and physiotherapy profession are less bright without you. Rest easy.

Richard Ellis [a b], Rachael De Jong [a], Sandra Bassett [a], Jake Helsby [a], Maria Stokes [c], Mindy Cairns [d]

505

Additional reading

KEY CLINICAL SKILLS

These articles are all open access and recommended reading for further study
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6779980/

SOUTH AFRICAN JOURNAL OF PHYSIOTHERAPY — The South African Society of Physiotherapy — AOSIS

S Afr J Physiother. 2019; 75(1): 1338.
Published online 2019 Sep 4. doi: 10.4102/sajp.v75i1.1338
PMCID: PMC6779980
PMID: 31616801

Physiotherapist's musculoskeletal imaging profiling questionnaire: Development, validation and pilot testing

Ogochukwu K.K. Onyeso,[1,2] Joseph O. Umunnah,[2] Peter O. Ibikunle,[2] Adesola C. Odole,[3] Canice C. Anyachukwu,[1] Charles I. Ezema,[1] and Maduabuchukwu J. Nwankwo[2]

506

Additional reading

These articles are all open access and recommended reading for further study
http://www.aulakinesica.com.ar/semioquirurgica/files/Comparison-of-referrals-for-lumbar-spine-mag.pdf

Physiotherapy

Physiotherapy 101 (2015) 82–87

Comparison of referrals for lumbar spine magnetic resonance imaging from physiotherapists, primary care and secondary care: how should referral pathways be optimised?

V. Parmar [a,*], L. Thompson [b], H. Aniq [a]

[a] Department of Radiology, Royal Liverpool and Broadgreen NHS Trust, Liverpool, UK
[b] Department of Physiotherapy, Royal Liverpool and Broadgreen NHS Trust, Liverpool, UK

507

Online radiology resources

http://uwmsk.org/residentprojects/
resident cases
http://www.learningradiology.com/index.htm
http://www.wheelessonline.com/ortho
online text
http://www.spineuniverse.com/professional
spine specific site
http://www.med.umich.edu/rad/muscskel/mskus/index.html
ultrasound site
http://www.ajronline.org/cgi/content/full/180/5/1431/FIG3
journal access
http://njms2.umdnj.edu/tutorweb/introductory.htm
intro to bone tumor
http://www.med.umich.edu/rad/muscskel/mskus/index.html
Good library of US technique and images

508

Online radiology resources

http://www.radiologyeducation.com/
many links out to sites
http://www.gentili.net/signs/
Great site
http://www.eurorad.org/
Cases +
http://www.medmatrix.org/_SPages/Radiology.asp
links to site
http://www.ctisus.org/teachingfiles/musculoskeletal
CT cases
http://www.bonetumor.org/images/
bone tumors
http://www.mypacs.net/mpv4/hss/casemanager
great cases can be searched with parameters – wow
http://www.auntminnie.com/index.aspx?sec=edu&sub=cdh&pag=archive
best site going

509

Thank you

510