Lesson 11: Role of imaging – X-ray, USG, CT, MRI, PET-CT

1. Why This Lesson Matters

As an Ayurvedic clinician working in oncology, you are **not** expected to read films like a radiologist.
But you *must* understand:

- What each imaging modality basically does
- When it is commonly used in cancer
- What kind of information it gives (size, spread, function, etc.)
- Limitations and safety issues (radiation, contrast, cost)
- How to explain these tests to patients who are scared or confused

If you understand imaging in this simple, clinical way, you will:

- Refer more appropriately and on time
- Interpret reports more intelligently
- Communicate better with oncologists
- Answer your patients' practical questions confidently

We'll cover five main tools: **X-ray, Ultrasound (USG), CT, MRI, PET-CT**.

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2. General Roles Of Imaging In Cancer Care

Across all cancers, imaging is used mainly for:

1. **Detection / Screening**
   - To pick up lumps or suspicious lesions (e.g., mammography).
2. **Diagnosis Support**
   - To locate the lesion and guide **biopsy** (USG/CT-guided).
   - Imaging alone usually doesn't "prove" cancer – tissue diagnosis is needed.
3. **Staging**
   - Finding **how big** the tumor is
   - Whether it has spread to lymph nodes
   - Whether it has spread to distant organs (metastasis)
4. **Treatment Planning**
   - Planning surgery (extent, operability)
   - Planning radiotherapy fields
   - Selecting chemotherapy / targeted therapy strategy
5. **Response Assessment**
   - Did the tumor shrink with treatment (CR, PR, SD, PD)?
   - Is there recurrence after surgery/chemo/RT?
6. **Complication & Follow-up**
   - Detecting complications: obstruction, perforation, effusion, etc.
   - Periodic scans in high-risk survivors to catch recurrence early.

You are not doing the scanning, but you must understand **why** it is done and what the report is roughly trying to answer.

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3. X-Ray – The Basic Workhorse

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3.1 What Is X-Ray?

- Uses **ionizing radiation** passing through the body to create a 2-D shadow image.
- Dense structures (bone, calcification) appear white.
- Air appears black. Soft tissues appear in shades of grey.

3.2 Common Oncologic Uses

- **Chest X-ray**:
  - Initial look for lung masses, mediastinal widening, pleural effusion, lung metastasis.
- **Bone X-ray**:
  - Suspected bone lesions, fractures due to bone metastasis, lytic/blastic changes.

It is **not very sensitive** for small or early lesions, but it is cheap, quick and widely available.

3.3 Advantages

- Low cost
- Easily available even in small centres
- Fast (few minutes)
- Useful as first screening test

3.4 Limitations

- 2-D view only; poor soft-tissue contrast
- Many small tumors and early lesions are **missed**
- Uses radiation (low dose but not zero)

3.5 Ayurvedic Clinician's Use

- Do not rely on chest X-ray alone to "rule out" lung cancer in a high-risk patient with strong red flags. Often CT is needed.
- Use X-ray reports to understand:
  - Rough lung status before certain therapies
  - Bone involvement in suspected metastasis
- Encourage patients to carry old X-rays for comparison (progression or improvement).

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4. Ultrasound (USG) – The Sonography Tool

4.1 What Is USG?

- Uses **high-frequency sound waves** (no radiation).
- Sound waves reflect differently from organs, fluid, and solid masses.
- A probe + gel on the skin; images are created in real time.

4.2 Common Oncologic Uses

- **Abdominal and pelvic organs**:
  - Liver, gallbladder, pancreas, spleen, kidneys
  - Uterus, ovaries, urinary bladder, prostate (TRUS in some settings)
- **Detecting masses, cysts, ascites (fluid in abdomen)**
- **Guiding procedures**:
  - Needle biopsies
  - Fluid aspiration (e.g., ascitic tap, pleural tap)
- **Neck USG**: thyroid nodules, lymph nodes

4.3 Advantages

- **No radiation** – safe in pregnancy, children, repeated use
- Real-time, dynamic; good for guiding needles and assessing organ movement
- Relatively low cost and widely available
- Useful for differentiating solid vs cystic lesions

4.4 Limitations

- Operator-dependent: quality depends on radiologist/sonologist
- Limited view in obese patients or if too much gas in bowel
- Less helpful for lungs (air interferes) and for deep structures covered by bone
- Gives less detail about complex anatomy than CT or MRI

4.5 Ayurvedic Clinician's Use

- A very good **first line** for abdominal/pelvic complaints and for follow-up of known cancers.
- For suspected ovarian, uterine, liver, kidney, gallbladder lesions – a baseline USG is usually essential.
- Encourage patients to do USG when you see warning signs, instead of only "dosha-based" diagnosis.
- Use USG findings to understand location, size, presence of ascites, organomegaly, etc., and adjust your expectations and therapy goals.

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5. CT Scan – Cross-Sectional Anatomy In Detail

5.1 What Is CT?

- **Computed Tomography** uses X-rays taken from multiple angles with computer reconstruction to produce **cross-sectional 2-D slices** (sometimes 3-D reconstructions).
- Often uses **IV contrast dye** to highlight blood vessels and organs.

5.2 Common Oncologic Uses

- **Staging** many solid tumors:
  - Lung, colon, stomach, pancreas, liver, kidney, ovary, uterus, head & neck, etc.
- Evaluating:
  - Size and exact location of tumor
  - Lymph node enlargement
  - Involvement of nearby structures (blood vessels, organs)
  - Distant metastasis (lungs, liver, adrenal, bone, etc.)
- Planning **radiotherapy fields** and surgery.

5.3 Advantages

- Much more detailed than X-ray
- Rapid scanning of whole body
- Good for bones, lungs, most abdominal organs
- Standard workhorse for staging and follow-up

5.4 Limitations

- Uses significantly more **radiation** than plain X-ray
- Contrast dye may cause:
  - Kidney strain (needs caution in renal impairment)
  - Allergy in some patients
- Less soft-tissue contrast than MRI for brain, spinal cord, some pelvic organs

5.5 Ayurvedic Clinician's Use

- When you see serious red flags (CAUTION U) → CT is often the appropriate next step (via oncologist/physician).
- Learn to read the **impression** and key words in CT reports:
  - "Mass lesion in…"
  - "Suspicious lymphadenopathy"
  - "Evidence of metastasis / no evidence of metastasis"
- Use CT staging information to understand:
  - Localized vs locally advanced vs metastatic disease
  - Whether the goal is curative or palliative
- Counsel patients about radiation exposure but do not create unnecessary fear – often the **benefit outweighs risk** in suspected/known cancer.

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6. MRI – Detailed Soft Tissue And Neuroimaging

6.1 What Is MRI?

- **Magnetic Resonance Imaging** uses a strong magnetic field and radio waves (no ionizing radiation).
- Gives excellent **soft tissue contrast**.
- Multiple sequences highlight different tissue properties.

6.2 Common Oncologic Uses

- **Brain and spinal cord tumors**
- **Head and neck cancers** – evaluating soft tissue spread
- **Pelvic organs**:
  - Uterus (endometrial, cervical cancers)
  - Prostate
  - Rectum (local staging)
- Musculoskeletal tumors and marrow involvement
- Liver and other abdominal organs where soft tissue detail matters

6.3 Advantages

- No ionizing radiation
- Best soft tissue contrast – shows planes, nerves, marrow, brain structures well
- Excellent for evaluating local extension around vital structures (e.g., spinal cord, brainstem, pelvic nerves)

6.4 Limitations

- More expensive than CT
- Longer scan time; patient must lie still in a narrow tunnel (claustrophobia for some)
- Not suitable for some metal implants and certain devices (pacemakers, cochlear implants), depending on model
- May use contrast agents (gadolinium) – usually safer for kidneys than CT contrast but still needs caution

6.5 Ayurvedic Clinician's Use

- Understand that MRI is often chosen when:
  - Brain or spinal symptoms are present (headache with neuro signs, seizures, limb weakness, etc.)
  - Detailed local staging is needed in pelvis or certain soft tissue tumors
- When a CT report says "MRI correlation advised", it generally means **more detailed soft-tissue assessment is needed**.
- Reassure patients about:
  - No radiation
  - Noise and enclosed space – teach them simple breathing/relaxation to manage anxiety.

7. PET-CT – Metabolic + Structural Imaging

7.1 What Is PET-CT?

- **Positron Emission Tomography + CT**:
  - A small amount of radioactive glucose (or other tracer) is injected.
  - Active tissues (often tumors) take up more tracer.
  - PET shows areas of **high metabolic activity**; CT gives anatomical map.
- The result is a combined image showing **where abnormal metabolic activity is located** in the body.

7.2 Common Oncologic Uses

- **Staging and restaging** of many cancers, especially:
  - Lymphomas
  - Lung cancers
  - Head and neck cancers
  - Some GI and gynecologic cancers
- Detecting **occult metastasis** not seen on CT/MRI
- Evaluating **response to therapy** based on metabolic activity, not just size
- Locating unknown primary tumors (when metastasis is known but primary site not found)

7.3 Advantages

- Whole-body survey of metabolic activity in one scan
- Helps differentiate:
  - Scar vs active tumor
  - Viable vs non-viable tumor after treatment
- Very useful for treatment planning and response assessment in many malignancies

7.4 Limitations

- Expensive and not available everywhere
- Uses radioactive substance (moderate radiation dose)
- Not all cancers are equally PET-avid; some low-grade or slow tumors may not show high uptake
- Inflammation or infection can also show increased uptake – false positives possible

7.5 Ayurvedic Clinician's Use

- Understand PET-CT is often ordered by oncologists for:
  - Precise staging before major decisions (e.g., transplant, high-intensity chemo)
  - Assessing remission vs residual disease in lymphoma and some solid tumors
- Learn the language in reports:
  - "FDG-avid lesions"
  - "SUV (Standardized Uptake Value)" – intensity of uptake
- Use PET-CT findings to:
  - Grasp overall disease burden (limited vs widespread)
  - Realistically set expectations for Rasayana, supportive care, and prognosis
- Help patients understand why such an expensive scan is sometimes justified in critical decision-making.

8. Safety Considerations You Should Know

8.1 Radiation Exposure

- Present in X-ray, CT, PET-CT (not in USG, MRI).
- Repeated imaging increases cumulative dose, but in cancer care, **benefit usually outweighs risk** when imaging is medically justified.
- Avoid trivial or repeated scans for minor reasons in children/pregnancy where possible.

8.2 Contrast Reactions

- CT contrast (iodinated):
  - Risk of allergy (mild to severe)
  - Kidney strain; caution in renal impairment
- MRI contrast (gadolinium):
  - Lower allergy risk; still use with care in renal failure
- Always ask patients about:
  - Previous contrast reactions
  - Known kidney disease
  - Asthma, multiple drug allergies

As an Ayurvedic clinician, you won't be prescribing contrast, but you should *ask and note* such histories and inform the radiology/oncology team if needed.

8.3 Claustrophobia and Anxiety

- MRI (and sometimes PET-CT) can provoke anxiety.
- Simple strategies:
  - Explain procedure calmly, duration, noises
  - Teach slow breathing, short mental japa or simple meditation
  - Encourage them to discuss sedation options with radiologist if claustrophobia is severe.

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9. How To Read Imaging Reports As A Non-Radiologist

You are not reading images; you are reading the **report**. Focus on:

1. **Clinical details section**
   - Why was the scan done? (Suspected CA, staging, follow-up?)
2. **Findings**
   - Tumor size (cm)
   - Location (which organ, which part)
   - Lymph nodes (size, number, location)
   - Distant lesions (liver, lung, bone, brain etc.)
   - Any complications (effusion, obstruction, fractures)
3. **Impression / Conclusion**
   - Usually 2–4 concise lines:
     - "Findings suggest…"
     - "Features are suspicious for…"
     - "No definite evidence of metastasis"
   - This section is the key for you to understand staging and severity.

Keep these reports carefully and encourage:

- Baseline + comparison over time
- You can quickly see if the tumor is "decreasing in size", "stable", or "progressing".

10. Integrating Imaging With Ayurvedic Decision-Making

Imaging helps you answer practical questions like:

- Is this **still local** or has it spread?
- Is the disease **operable / potentially curable**, or more **palliative**?
- Is the patient getting **better, stable, or worse** with ongoing therapy?

With that information, you can:

- Decide whether to push for complete modern treatment or focus more on symptom relief.
- Choose intensity of Rasayana and Brimhana (more in stable survivors, gentler in uncontrolled disease).
- Counsel patient and family honestly about goals: cure, control, or comfort.
- Time your Panchakarma ideas very carefully (and avoid heavy procedures in advanced metastatic disease).

Remember:

> Imaging does not replace your Ayurvedic understanding; it **adds objective external vision** to your internal doṣa–dhātu–srotas assessment.

Both are needed for rational integrative oncology.

11. Key Take-Home Points

1. Imaging in oncology is mainly for **detection, staging, planning, response assessment, and follow-up**.
2. **X-ray** – basic, cheap, 2-D; good for chest screening and bone changes, but limited detail.
3. **USG** – no radiation, good for abdominal/pelvic organs, cysts vs solid, fluid; highly operator-dependent.
4. **CT** – detailed cross-sections, excellent for staging most solid tumors, uses radiation and iodinated contrast.
5. **MRI** – best for soft tissues, brain, spine, pelvis; no radiation but more expensive and time-consuming.
6. **PET-CT** – combines metabolism + anatomy; powerful tool for staging, restaging, and response assessment in many cancers.
7. As an Ayurvedic clinician, you must:
    - Recognise when imaging is needed (based on red flags)
    - Read and use imaging reports intelligently
    - Explain procedures and reassure patients
    - Integrate imaging findings with your Ayurvedic assessment for realistic, ethical, integrative care.

12. Review Questions

1. List the main clinical purposes of imaging in cancer care.
2. How does USG differ from CT in principle, advantages, and limitations? Give two oncology examples where USG is usually the first test.
3. In which situations is MRI preferred over CT in cancer patients? Give at least three examples.
4. What additional information does PET-CT provide compared to a plain CT scan?
5. What safety issues should you remember about CT and PET-CT? How would you explain these to a worried patient?
6. A 55-year-old smoker has a suspicious lung mass on X-ray. Outline the likely sequence of imaging tests and how you will use their reports in your Ayurvedic planning.
7. How can imaging findings influence your decisions about Rasayana intensity and Panchakarma planning in different

stages of malignancy?

End of Lesson 11