# Dr. Moghtaderi's Guide to Reading Orthopaedic X-Rays

**Sam Moghtaderi, MD**

First of all, reading x-rays in orthopaedics is akin to interpreting EKGs in cardiology. It's our thing. We do it all the time, we do it a certain way, and if you are a medical student rotating on orthopaedics or an intern or junior resident, the sooner you learn to do it in our style the sooner you'll look good doing so!

Second, you of course want to not only look smart reading x-rays, but you want to interpret them completely and accurately.

This guide is intended to give you a framework for accomplishing both.

If you just want the basic outline, fast forward to **Part 3** below. Otherwise, read on for the details.

## Part 1: Style

1. Always start by saying what we are looking at. This includes modality, body part, views, skeletal maturity, and laterality. Starting with this phrase is very much an accepted convention among orthopaedic surgeons.

   *"Three plain film views of a skeletally immature right hand"*
   *"AP, Lateral, and Sunrise views of the left knee in a skeletally mature individual"*
   *"Sagittal plane CT scan of the elbow"*
   *"T1-weighted coronal plane sequence MRI of the knee"*

2. Avoid automatically qualifying your statements with doubt or uncertainty, unless you are actually intending to convey doubt or uncertainty. In that case do it clearly and explicitly.

   Don't say "I think I may possibly see a likely fracture line in the distal radius". Say "There is a fracture line in the distal radius." We all already know that what you are saying is your interpretation of what you think you see, not necessarily what is The Truth.

   On the other hand, it is perfectly okay to convey actual intended uncertainty by saying "This lucent line in the metaphysis of the radius may represent a non-displaced fracture, but may also be regular trabecular pattern or a nutrient vessel."

3. Silence your natural tendency to buy time by saying **"umm…"**, **"hmm…"**, and other utterances. Everybody has a tendency to do that, especially if you are put on the spot and trying to think. **Staying silent for a second or two between your two sentences is totally fine**, and sounds much more polished than filling that space with an "umm…", yet we all tend to do the latter. Be aware of this and you can avoid it.

## Part 2: Substance

It is easy to focus on an obvious fracture on an X-ray, and forget to look at all the other details. It's also easy to look at a relatively normal-looking X-ray, and feel like you have nothing to say about it because it is so unremarkable. You want to avoid both of those scenarios, since you can either miss things, or just look unintelligent by saying "This is a negative X-ray" without showing that you did fully assess it.

All of us were probably taught in medical school to look at chest x-rays systematically—*i.e.* don't just jump straight to the heart and lungs… Look at the bones, the mediastinum, the trachea, the diaphragm, *etc.*

Well, we can use a similar framework to look at musculoskeletal imaging completely. I like to break it up into 4 categories:

1. **Fractures** - Much more on this later
2. **Alignment** - Subluxation, dislocation, instability (*e.g.* varus/valgus, DISI, *etc.*)
3. **Degenerative changes** - You do know the 4 radiographic signs of OA, right?†
4. **Lesions/Masses/Soft tissue** - Discrete masses, bone lesions, soft tissue swelling

Running through just these 4 categories in your mind lets you make sure that you are thorough in looking at all aspects of the film even if there is a glaring fracture to talk about. It also gives you 4 areas to explicitly asses, if the X-ray looks fairly unremarkable at first glance. It is a lot smarter to say all the negatives you noted on an unremarkable X-ray than to just say it is normal. Doing the former lets you "show your work" and lets me, as the listener, know that you looked at the things I hope you've looked at.

*"These are PA, lateral, and oblique views of a skeletally mature wrist. I do not appreciate any fractures. Alignment of the carpal bones is well-maintained. Joint spaces do not demonstrate any significant degenerative change or arthritis. No discrete lesions are noted."*

Now that sounds like someone who interpreted an X-ray thoroughly, and you as the listener can know that. You wouldn't know that if they just said this was a normal wrist.

† (The 4 radiographic signs of OA, by the way, are joint space narrowing, osteophytes, subchondral sclerosis, and subchondral cysts)

**Let's Talk About Fractures.**

Sometimes fractures are obvious and can be seen from across the room. But when they are not, a good way to scan for fractures is to have your eyes follow each joint surface, as well as each bone's cortical surface, and look for any cracks, discontinuity, or step-off.

Once you have noted a fracture, you want to be systematic about describing the fracture. Your goal is to describe it **succinctly**, yet with **enough detail** that if someone were listening to you on the phone without seeing the X-ray, they could reasonably sketch out a schematic that matches the X-ray you are describing. So we are going to breakdown our #1 category above with 4 additional subcategories:

A. **What bone?**
B. **What location on the bone?** - Proximal/distal/intra- or extra-articular/metaphysis/diaphysis
C. **Fracture pattern** - Transverse/oblique/spiral/comminuted/*etc*.
D. **Displacement** - What direction, what type, and how much?

Be systematic and go through these 4 categories in order. Don't keep jumping back and forth and intermingle location with displacement then fracture pattern, etc.

When we talk about **displacement** of a fracture (or dislocation or other malalignment), the convention is to describe **the direction that the distal fragment has moved**. Sometimes this is counterintuitive, but that is the convention. This applies regardless of the **type** of displacement you are talking about. What are the **types** of displacement you can have?

- **Angulation**
- **Translation**
- **Length** - Usually this means shortening, but could be distraction/separation as well
- **Rotation** - Often hard to see on X-rays unless glaring

When we talk about **angulation**, remember that all displacement is described with respect to the direction that the distal fragment has moved. This is the opposite of how one might intuitively think of the angulation as being in the direction of the pointy end ("apex") of the angle. If you would like to describe from the perspective of the where the pointy end is pointing, that is actually okay too, but **you must include the word "apex" in your description** to indicate this convention.

For example, if you have a femoral shaft fracture with coronal plane angulation and the knee is more medial and the pointy end of the fracture is pointing laterally, you can describe that correctly as **either** *"medial angulation"* or *"apex-lateral angulation"*. The point is that you have to either describe the direction of the distal fragment, or use the word "apex". It would be incorrect in this case to say "lateral angulation", which would describe the opposite direction to what we have.

As a bonus fact, you should learn the terms **varus** and **valgus**. We use those as shorthand for describing angulation in the coronal plane. The example above with the femur describes varus angulation, and the opposite direction would be called valgus. Simply put:

**Varus** = Apex-lateral angulation (think "bow-legged")
**Valgus** = Apex-medial angulation (think "knock-kneed")

These two words are just shorthand. It is not incorrect to just describe the angulation direction as per normal conventions and not use these words, but you should know them as they are commonly used. They can be applied to any location where you are describing coronal plane angulation, be it a bunion, femoral shaft, hip fracture, or humerus.

You can, of course, also have angulation in the anterior and posterior directions.

When referring to the **upper extremity** distal to the elbow, because the forearm can flip over by supinating and pronating, it is convention (and less ambiguous) to use the terms **radial** and **ulnar** to describe direction of displacement rather than medial, lateral, valgus, or varus.

To quantify **how much** displacement, we can of course use degrees for angulation and rotation, and millimeters or centimeters for translation and length. For translation, you can also use a relative measure, like "50% of the diameter" for a shaft fracture.

If there is displacement of more than one type, just describe each in succession.

## Part 3: Putting it All Together

So here is the outline that you should run through in your mind for every x-ray. Comment on each applicable part, be it a pertinent positive or negative, and you will end up with an interpretation that is thorough and polished:

**Introduction:** What are we looking at?

1. Modality
2. Body part
3. Views
4. Skeletal maturity
5. Laterality

**Interpretation:** What are the findings?

1. Fractures
    - **A.** What bone?
    - **B.** Location on the bone
    - **C.** Fracture pattern
    - **D.** Displacement
        - Angulation
        - Translation
        - Length
        - Rotation
2. Alignment
3. Degenerative Changes
4. Lesions/Masses/Soft Tissues

**Bonus:**

> After you feel you have said there is all there is to be said about the x-ray, force your eyes to **take one more lap** around the x-ray, and **say one more fact about the image**. It doesn't matter if that fact is important or useful or relevant. But this is a good exercise to force you to take one more look and make sure you did not miss some second fracture in a tiny bone in the corner. Even if you just end up point out that a 20-year-old's joints are not arthritic. You will be amazed how often this will make you notice another injury that you might have missed, an old deformity, or some congenital difference. *(Credit for this tip goes to Dr. Bob Goitz at the University of Pittsburgh)*

*I hope you have found this guide useful. It is the framework that I have come to teach to our orthopaedic residents over the course of many years. Do you have your own pearls or suggestions for how I can improve this guide? Let me know online (@DrSam on Threads).*