Technical guide of musculoskeletal CT: Fundamental aspects that a radiographer needs to know for daily practice.

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Learning objectives

The objective of our work is to create a technical guide of musculoskeletal CT showing the key aspects that a radiographer needs to know for daily practice.

Background

CT has become a technique widely used in pathology of the musculoskeletal system, because its availability and speed. Also it provides us spatial information due to the possibility of do multiplanar and volumetric reconstructions. In daily practice, knowledge of the different technical parameters is essential to optimize the exploration, thereby performing the tests under the right approach and appropriate image quality.

Findings and procedure details

We analyze the correct patient positioning and basic guidelines to post-processing images (multiplanar and 3D reconstructions) to get a good quality image in principal studies of musculoskeletal CT:

*Upper extremity:

1. Shoulder.

Patient should be placed in supine position, with affected arm extended parallel to the body and contralateral arm raised above his head. Scout includes from the upper margin of the acromioclavicular joint to the lower border of the scapula, including the proximal humerus. Fig. 1 on page 6

In post-processing, we use glenohumeral reference line to do multiplanar reconstructions (MPR), coronal plane perpendicular to the reference line and sagittal plane parallel to the reference line. Fig. 2 on page 6.

We should use always a large kernel filter (B60-B70) for MPR images and a low kernel filter (B20-B30) for 3D reconstructions because in this way we can reduce noise and increase resolution. Fig. 3 on page 7

*Remember: 3D imaging provides spatial information defining adjacent structures and approach the most appropriate therapeutic management.*
2. Elbow.

Patient should be placed in prone position, with elbow flexed at 90°, thumb up and elbow on the table center. These are standard guidelines, but this will depend on the general condition of patient, in some cases as polytraumatized patient or with limited mobility, we can use supine position and elbow away from the body as much as possible.

Scout includes from the middle humeral shaft to the middle radius and ulnar shafts. Fig. 4 on page 8

In post-processing, we use a interepicondylar reference line to do multiplanar reconstructions (MPR), coronal plane paralell to the reference line and sagittal plane perpendicular to the reference line. Fig. 5 on page 9. 3D reconstructions are very important in the elbow because it allows us to get a better spatial orientation in a complex joint such as the elbow.

*Remember: Anatomical coverage should includes the pathology area for study, along with a portion of adjacent bone or joint, for a correct anatomical orientation.*

3. Wrist.

Patient should be placed in prone position, with arm extended above head and as straight as possible, forearm in a neutral position and palm down on the table center. Scout includes from radial and cubital proximal diaphysis through base of metacarpals. Fig. 6 on page 10

In post-processing, we use a radiocubital reference line to do multiplanar reconstructions (MPR), coronal plane parallell to the reference line and sagittal plane perpendicular to the reference line. Fig. 7 on page 11. 3D reconstructions provide us a rapid spatial vision.

*Remember: A low pitch improves image quality in the Z axis (the axis of study) and it’s very useful in small anatomical structures.*

*Lower extremity:*


Patient should be placed in supine position, with legs extended on table and tape feet together with toes pointing up to help a slight internal rotation. Scout includes from iliac crests to ischial tuberosities. Fig. 8 on page 12

In post-processing, we use a reference line passing through the center of femoral heads to do multiplanar reconstructions (MPR), coronal plane parallell to the reference line and
sagittal plane perpendicular to the reference line (from acetabulum to greater trochanter). **Fig. 9** on page 13. 3D reconstructions are very useful.

Hip scanner is exactly the same, only limit the study area from acetabular roof to lesser trochanter.

*Remember: To achieve good quality reconstructions it is necessary overlap in axial slices, thereby avoiding the "stair effect" of the image.*

2. **Knee.**

Patient should be placed in supine position, knee extended (or slightly bent on a support bracket) and parallel to the axis of the table, with slight internal rotation (centered patella). Scout includes from suprapatellar region to the tibial proximal diaphysis. **Fig. 10** on page 14.

In post-processing, we use a reference line passing through the posterior border of tibial plateaus to do multiplanar reconstructions (MPR), coronal plane parallel to the reference line and sagittal plane perpendicular to the reference line. **Fig. 11** on page 15.

3. **Ankle.**

Patient should be placed in supine position, with the leg extended parallel to the table and we can use a support brace to support of plantar foot. Scout includes from distal diaphysis of the tibia to calcaneous and from calcaneous to metatarsals. **Fig. 12** on page 16.

In post-processing, we use a tibiofibular joint reference line to do multiplanar reconstructions (MPR), coronal plane paralell to the reference line and sagittal plane perpendicular to the reference line. **Fig. 13** on page 17. 3D imaging is helpful as we have previously discussed.

*Remember: A use of small Fields Of View(FOV) and higher reconstruction matrix size we will provide higher spatial resolution.*

Here is a table that lists the parameters used in our hospital for musculoskeletal CT studies.
On the other hand, it is important to recognize those studies that require intravenous contrast administration, such as:

1. Polytraumatic patients or suspicion of active bleeding.
2. Infections (osteomyelitis, septic arthritis..)
3. Tumors.

Finally, we show different applications of dual energy in musculoskeletal system:

1. **Gout**: Characterizes the chemical composition of each material according to the different X-ray attenuation, using two power levels (80kV and 140Kv). Dual energy allows the separation and characterization of calcium (high molecular weight compound) from uric acid (compound of low molecular weight). Calcium color coded in blue and uric acid color coded in green. **Fig. 15** on page 18

2. **Reduction of metallic artefacts in postsurgical patients**: We have a broad energy spectrum with the two tubes (80 kV and 140 kV) and we can choose an optimal energy level (monoenergetic reconstruction) to reduce metallic artefacts. You can see the difference between dual and simple energy CT. **Fig. 16** on page 19
Images for this section:

Fig. 1

**SHOULDER**

**Patient positioning**
- Supine decubitus
- Affected arm extended parallel to the body
- Contralateral arm raised above his head

**Scout**
Fig. 2

SHOULDER

Post-processing: MPR

Sagittal

Glenohumeral reference line

Coronal
Fig. 3

SHOULDER

Post-processing: 3D

SMALL kernel filter (B20-30)  LARGE kernel filter (B60-70)
ELBOW

Fig. 4
Fig. 5
Fig. 6

Fingers are flexed as in the mouse position and wrist parallel to the table.
Fig. 7
PELVIS

Patient positioning
- Supine decubitus
- Legs extended on table
- Slight internal rotation

Scout

Fig. 8
Fig. 9
Fig. 10

- Supine decubitus
- Knee extended and parallel to the axis of the table
- Slight internal rotation (centered patella)
Fig. 11
Fig. 12

- Supine decubitus
- Leg extended parallel to the table
- Support brace
Fig. 13
Conclusion

Knowledge of the technical aspects of musculoskeletal CT is very important to acquire and post-processing a high quality image, and of this way, improving to workflow of radiologists and clinical or therapeutic management of patients.

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References


