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Functional Orthopedic Imaging Capturing Motion, Flow and Perfusion

ONE
Aquilion
dynamic volume CT

Case Study Brochure
Centre University Hospital Nancy



TOSHIBA MEDICAL SYSTEMS CORPORATION

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ONE
Aquilion

Dynamic Volume CT

Centre University Hospital Nancy, France

Introduction

The Aquilion ONE™ CT system was installed in Centre University Hospital Nancy in June 2008, and is the main CT system for performing musculoskeletal and trauma examinations in our institute. This CT scanner is unique with a detector that is able to acquire up to 16 cm of anatomical coverage in a single volumetric rotation, and is therefore able to provide true dynamic volume scanning. These capabilities have opened an array of new possibilities in the diagnosis of a variety of musculo-skeletal disorders that have not been possible with any other imaging modality.

Patients who suffer pain during movement in a variety of everyday activities often have no obvious structural abnormalities, and diagnosis and treatment have been largely based on clinical diagnosis. Dynamic volume scanning performed as the patient reproduces the motion causing discomfort is able to capture the often complex mechanical abnormality causing the patients symptoms. As such, superior treatment decisions can be made for a wide variety of musculo-skeletal functional disorders.

In addition, dynamic volume imaging is able to capture perfusion with the administration of contrast medium, and has revolutionized the way we assess tumors of the musculoskeletal system. Advanced subtraction software that features a pixel perfect deformable registration algorithm produces incredible 3D DSA images from these studies. These subtracted images permit accurate assessment of tumor invasion into cortical and medullary bone and the surrounding soft tissues providing conclusive or highly probable diagnosis for patients with musculoskeletal lesions.

Combining joint motion studies together with the administration of contrast media provides the ability to assess vascular impingement syndromes with a single low dose examination providing high-fidelity 3D image display.

Some examples of these exciting new applications of dynamic volume CT are shown in this publication.



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WARNING: Any reference to x-ray exposure, intravenous contrast dosage, and other medication is intended as a reference guideline only. The guidelines in this document do not substitute for the judgment of a healthcare provider. Each scan requires medical judgment by the healthcare provider about exposing the patient to ionizing radiation. Use the As Low As Reasonably Achievable radiation dose principle to balance factors such as the patient's condition, size and age; region to be imaged; and diagnostic task.

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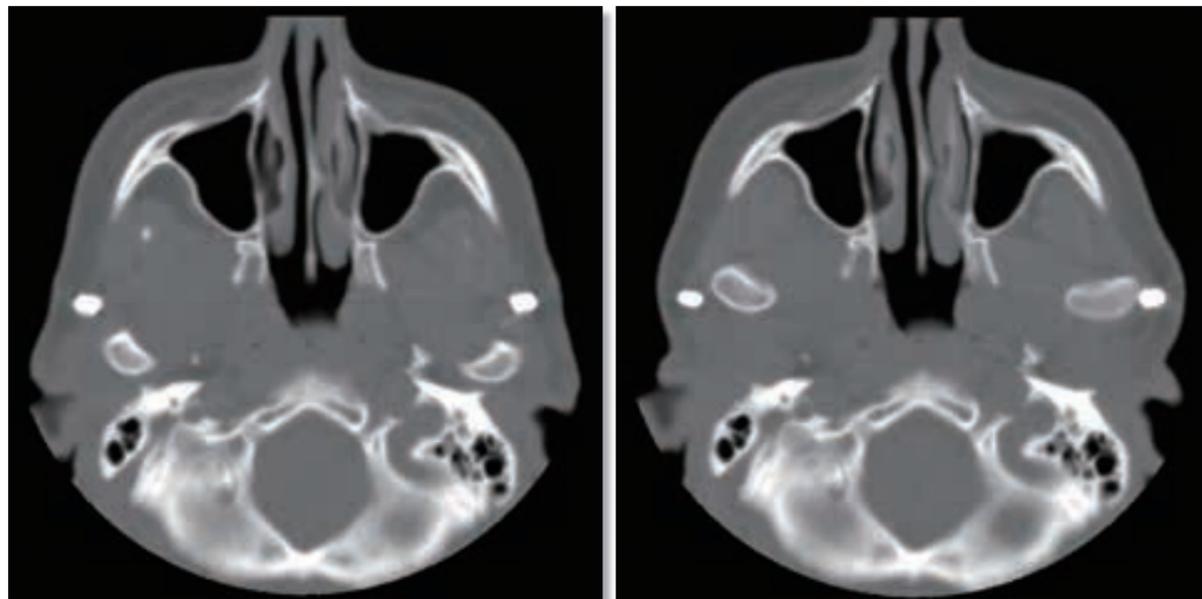
Anterior Translation of Mandibular Condyles

Patient History

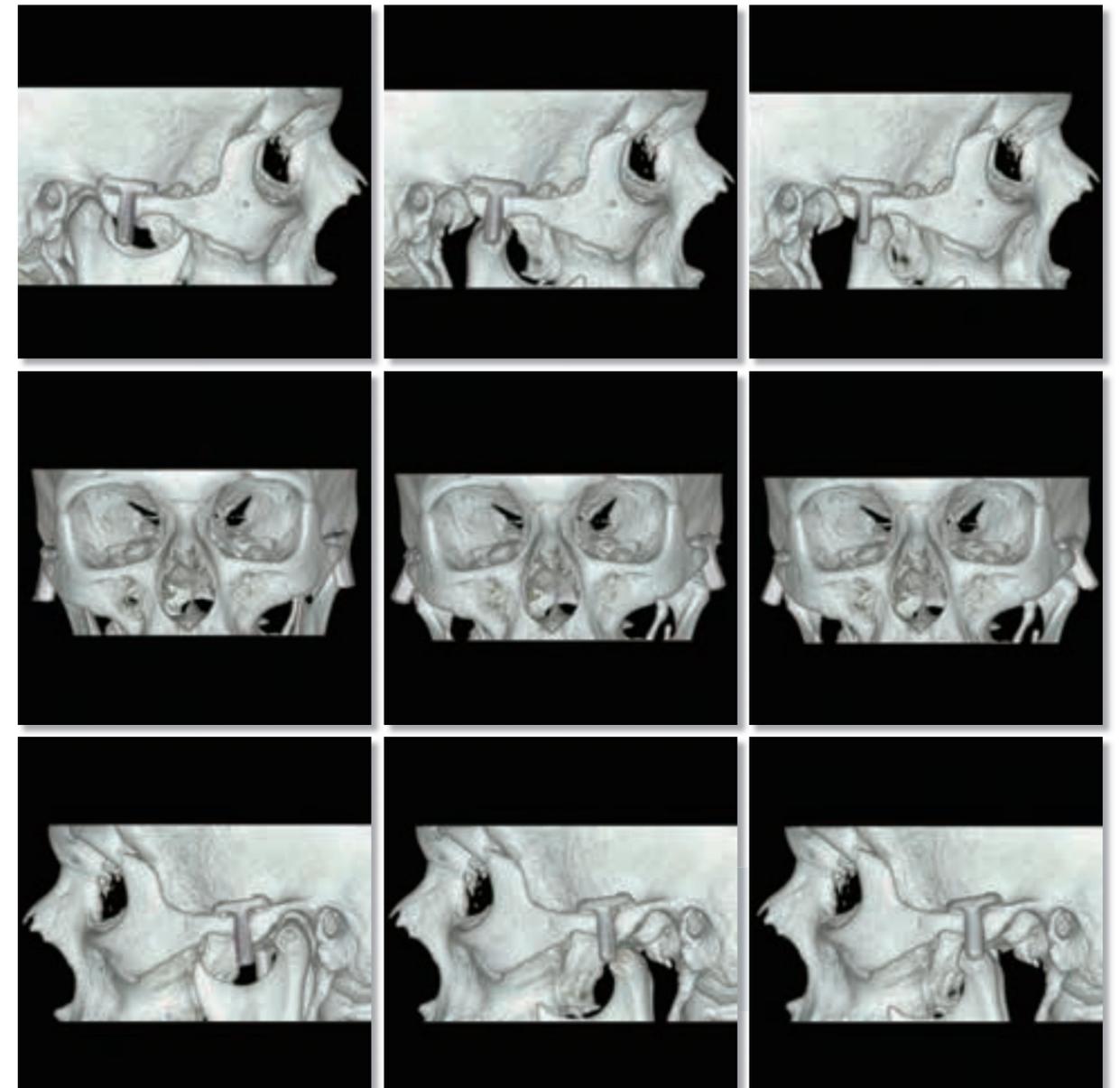
This 39-year-old woman presented with excessive anterior translation of the mandibular condyles, which had previously been treated surgically. She now complains of persistent pain and abnormal Temporo-Mandibular Joint motion.

Scan Protocol

Dynamic intermittent scanning at 1.4 second intervals was performed during opening and closing of the mouth.



Images obtained with the mouth closed and fully open demonstrate the position of the mandibular condyles in relation to the metallic restraint devices.



Conclusion

This dynamic CT study of the TMJ during mouth opening demonstrates persistent excessive anterior translation of the mandibular condyles. The surgical restraints are displaced laterally in the latter stages of mouth opening.

Thoracic Outlet Syndrome

Patient History

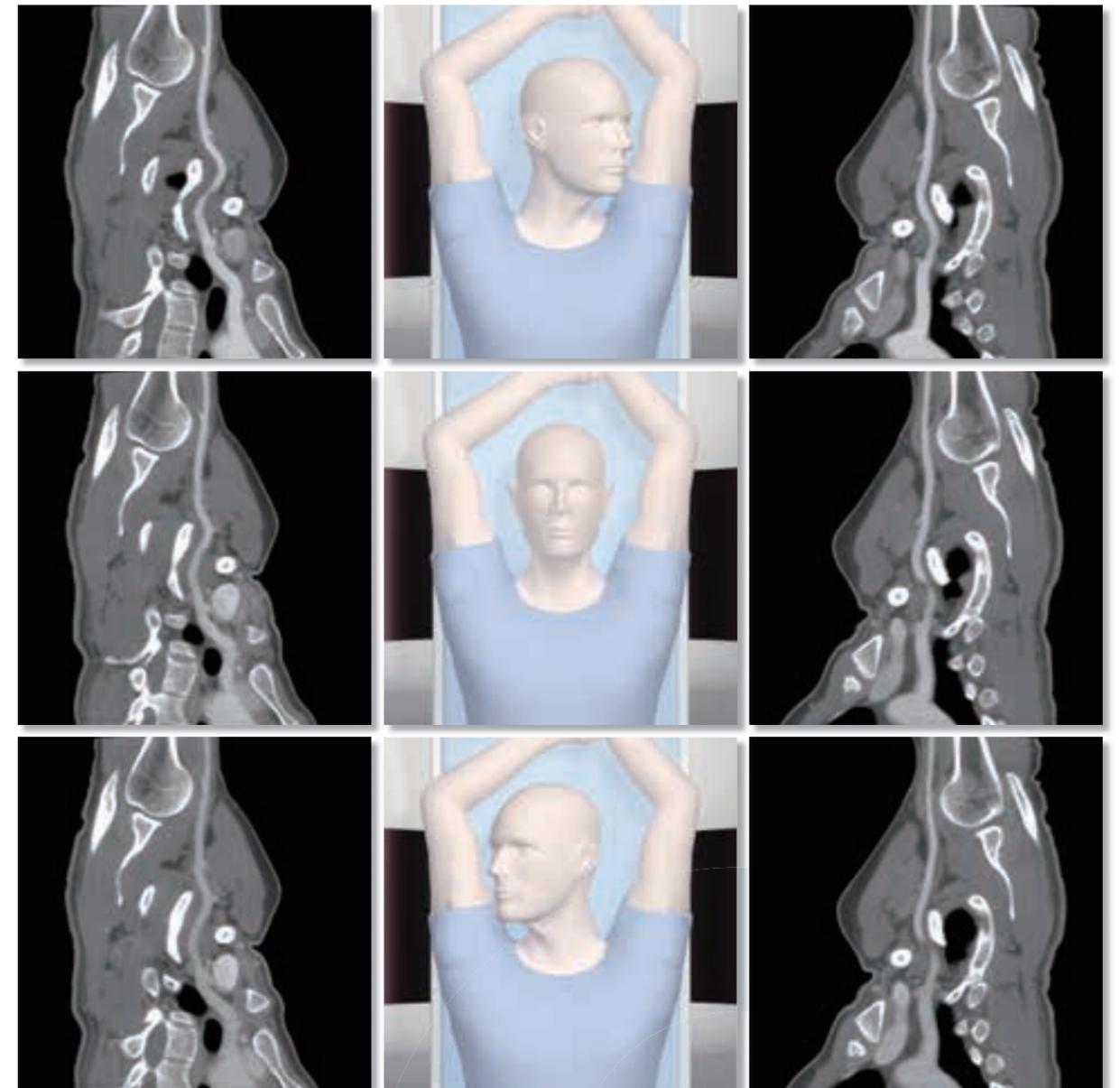
This 20-year-old man presented with pain and paresthesia of the left upper limb during physical activities involving arm movements above the shoulder.

Scan Protocol

Dynamic intermittent scanning was performed during the injection of 75 mL of intravenous contrast agent. The volumes were acquired during movement of the head from left to right. The arms remained raised above the head during scanning. The entire scan was performed in 8 seconds.



3D-rendered images demonstrate bilateral cervical ribs.



Conclusion

The dynamic CT angiography study of this region during left-to-right head movement demonstrates compression of the left subclavian artery by the cervical rib when facing right, confirming the diagnosis of thoracic outlet syndrome.

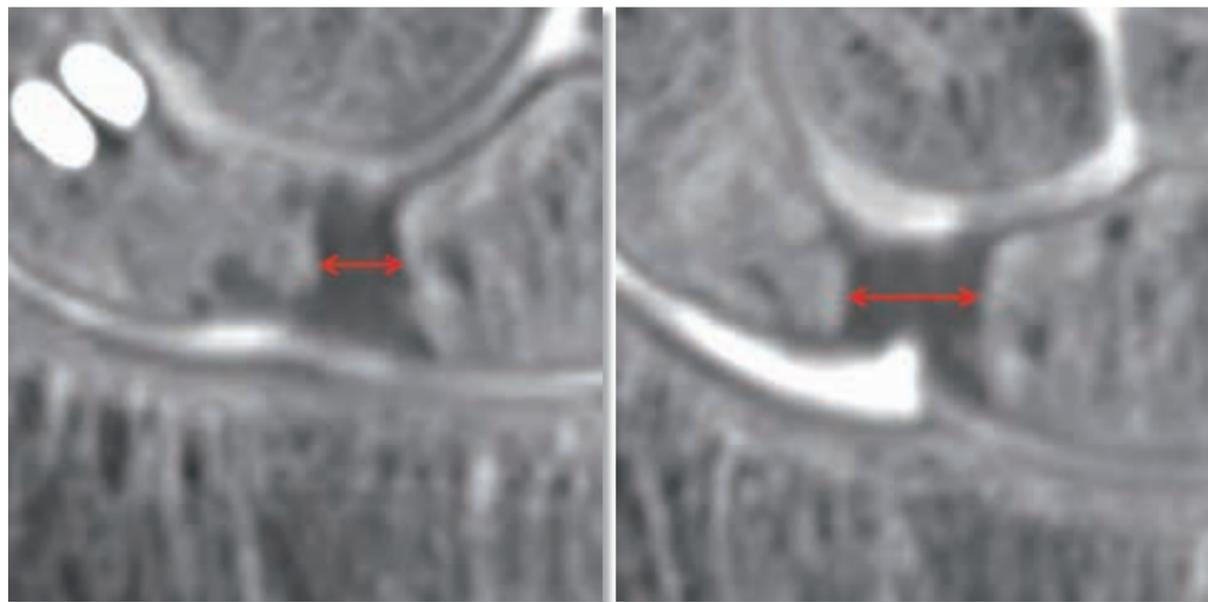
Carpal Instability

Patient History

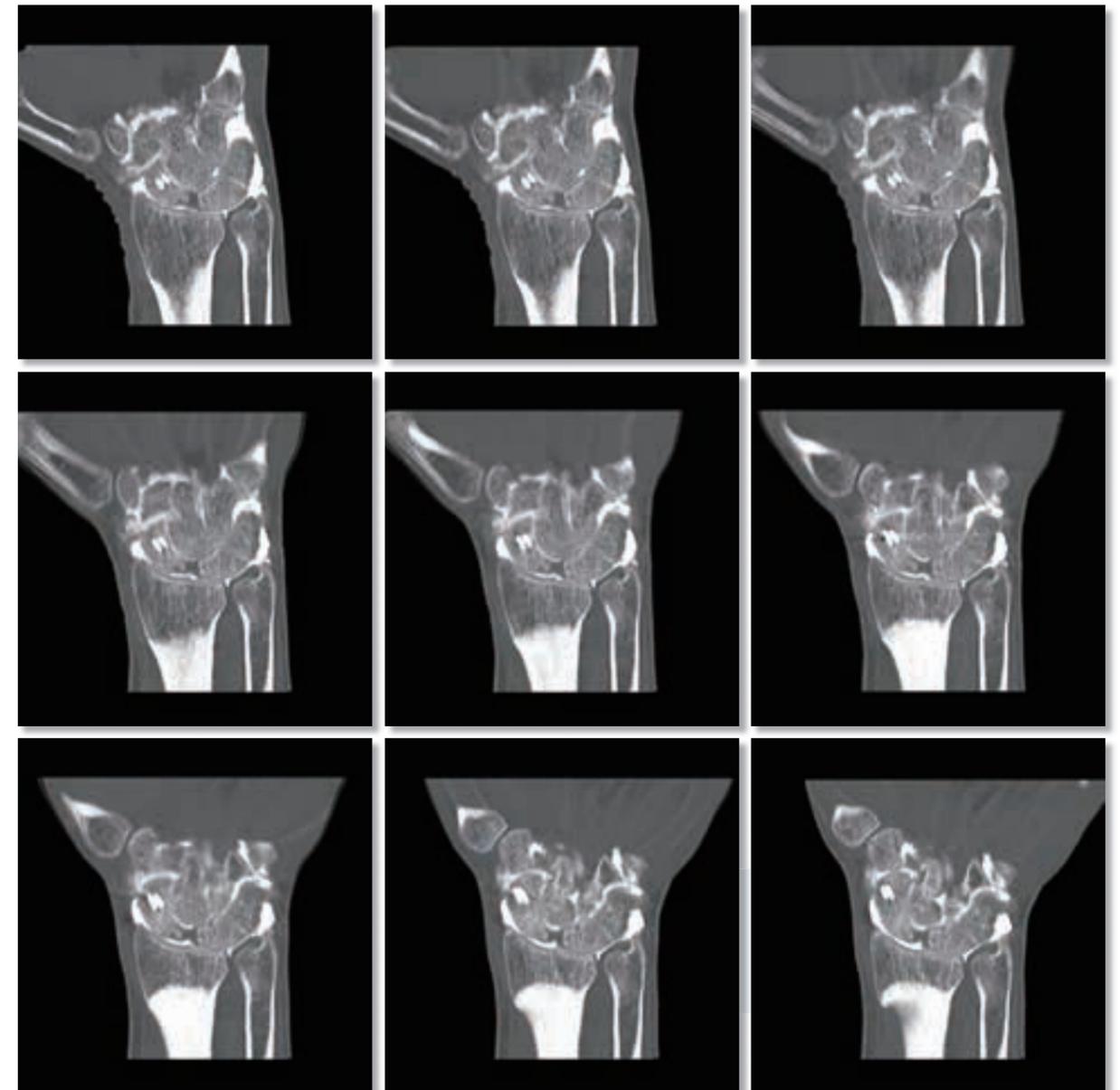
This 40-year-old man presented with persistent right wrist pain following surgical treatment of a fracture of the proximal pole of the scaphoid bone with reconstruction of the scapholunate ligament. A wrist arthrogram was performed to visualize the ligament.

Scan Protocol

Following the injection of iodinated contrast agent into the wrist joints, dynamic intermittent scanning was performed from maximum radial deviation to maximum ulnar deviation of the right wrist. The scan time was 15.4 seconds, and 8 volumes were reconstructed every 1.4 seconds.



Images of the scapholunate space during maximum radial and ulnar deviation demonstrating widening of the scapholunate space.



Conclusion

The CT arthrogram shows thickening of the scapholunate ligament, which remains continuous. Dynamic CT during radio-ulnar deviation confirms persistent insufficiency of this ligament with persistent scapholunate diastasis. The final diagnosis is dynamic dissociative carpal instability.

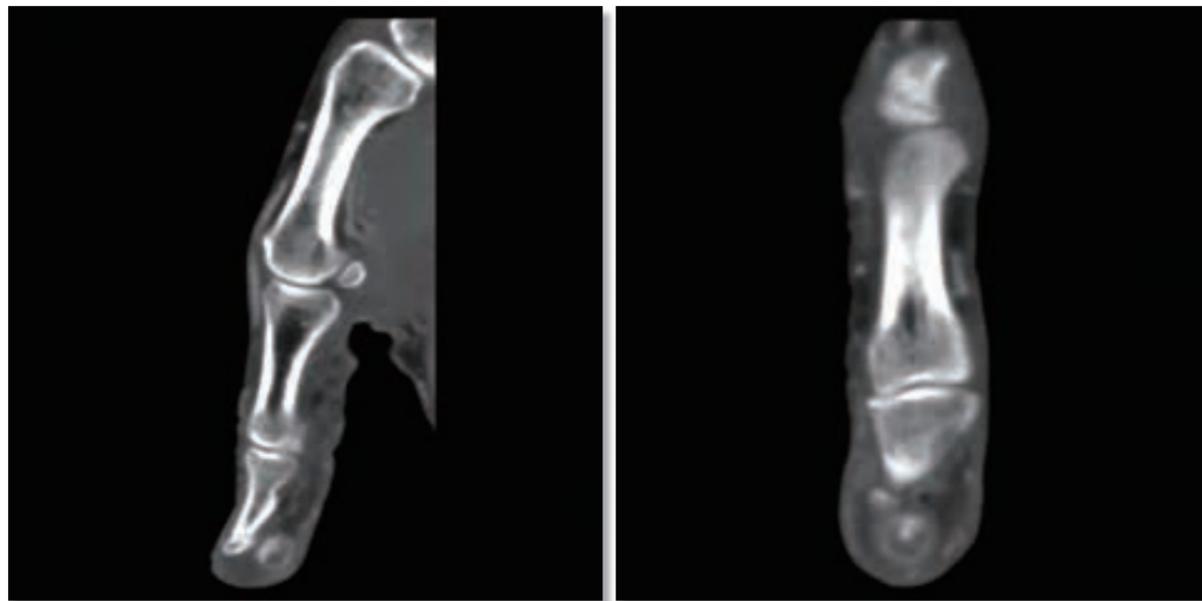
Para-osteal Mass

Patient History

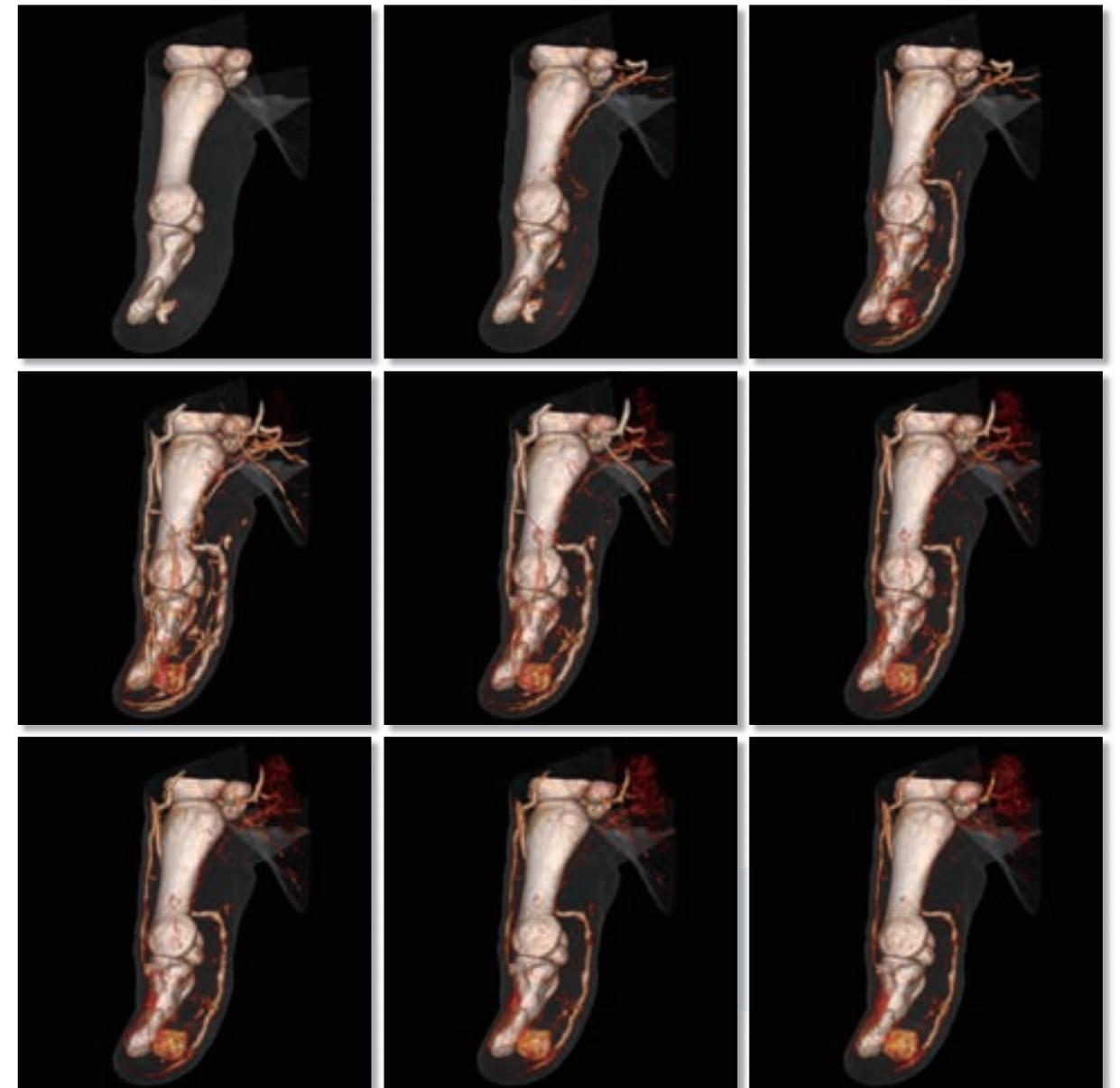
This 65-year-old woman presented with a partially calcified mass of the thumb pad that first appeared 1 year ago and has recently increased in size.

Scan Protocol

During the injection of 150 mL of contrast agent, dynamic intermittent scanning was performed to better define the mass and its blood supply.



Enhancement of the mass is clearly seen in these sagittal and coronal images.



Conclusion

The dynamic CT images demonstrate a para-osteal soft tissue mass with dystrophic calcifications. The lesion is seen to be highly vascularized by dynamic CT angiography, which depicts the relationships of this mass to the adjacent arteries and veins. These findings are suggestive of para-osteal osteochondromatous proliferation or Nora's tumor.

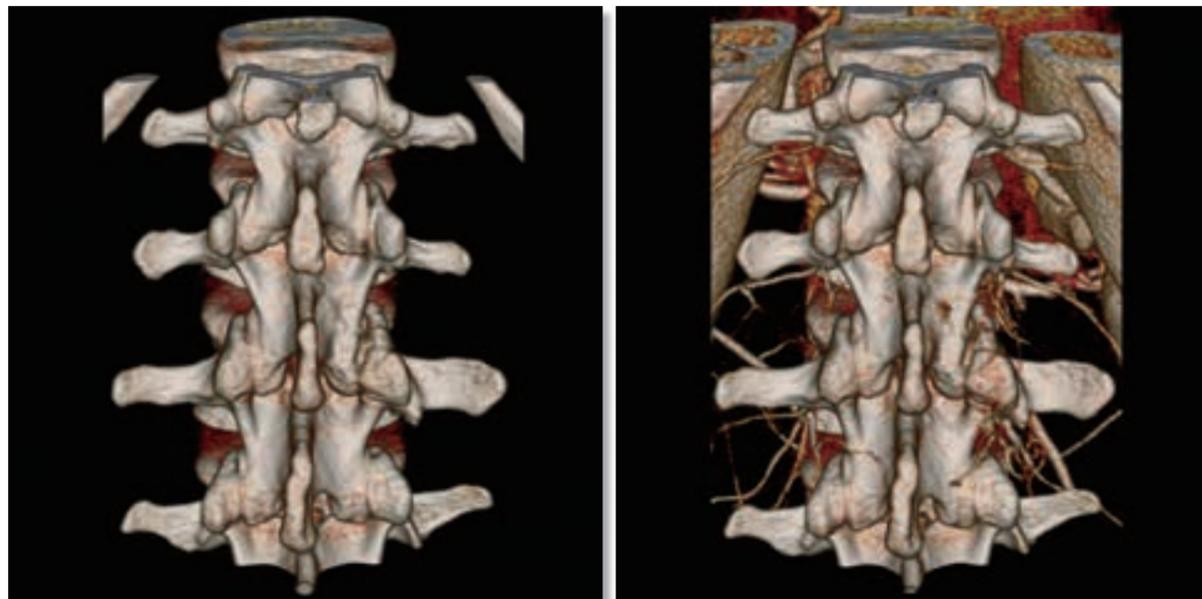
Osteoid Osteoma of Lumbar Vertebra

Patient History

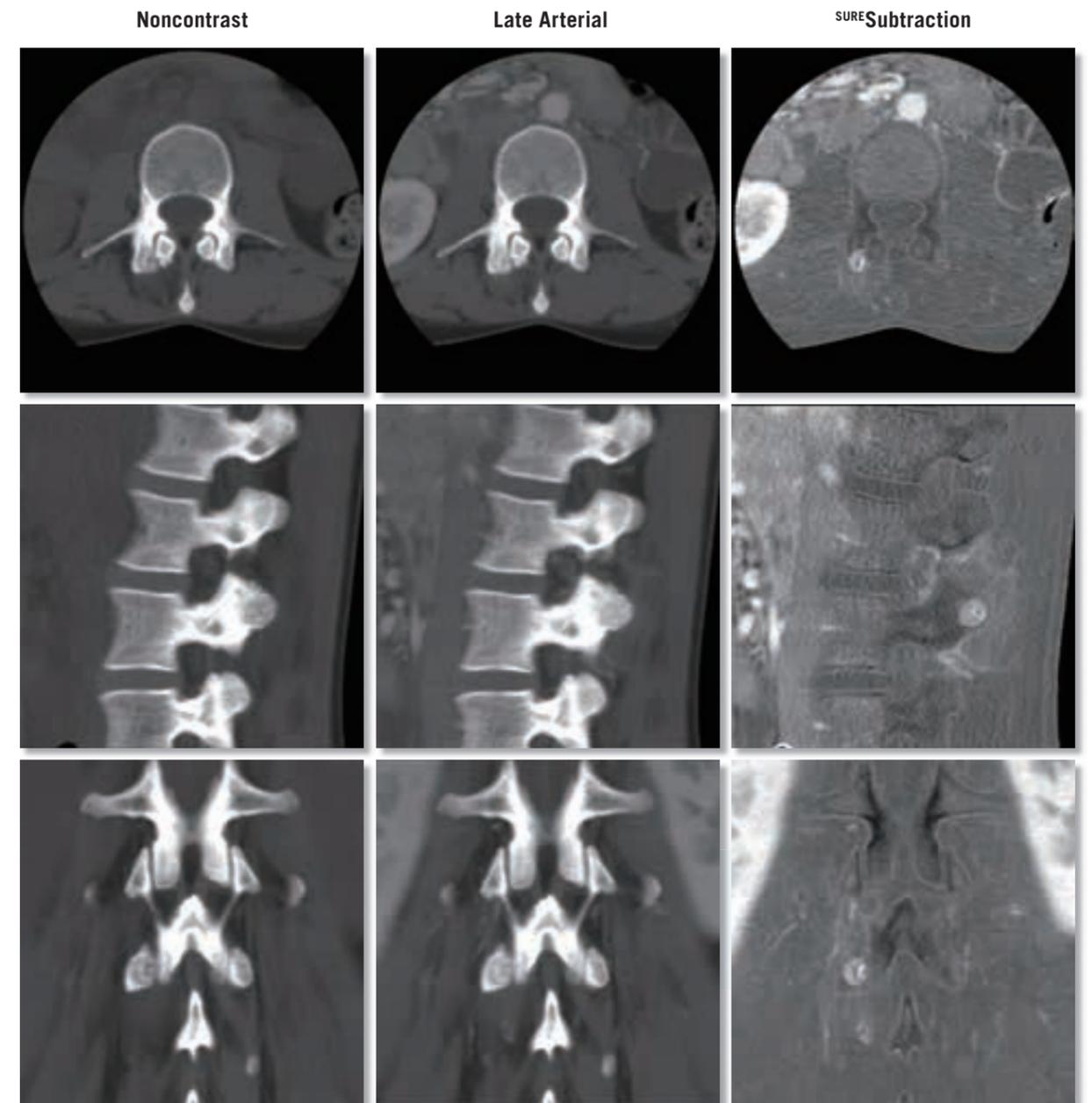
This 32-year-old woman presented with chronic back pain. An MR examination (not shown) demonstrated nonspecific inflammatory changes of the right superior articular facet of the second lumbar vertebra.

Scan Protocol

Dynamic intermittent scanning was performed during the injection of intravenous contrast agent. Each volume was subtracted from the noncontrast volume using the ^{SURE}Subtraction™ Ortho software.



Noncontrast and late arterial images of the lumbar spine demonstrate that the lesion cannot be visualized without subtraction.



Conclusion

Dynamic CT angiography with DSA-like bone subtraction demonstrates a well-defined lesion in the right superior articular facet of L2. The lesion shows early enhancement, with enhancement of the surrounding bone marrow in the late phases.

These findings confirm the diagnosis of osteoid osteoma of the second lumbar vertebra with reactive bone marrow edema-like changes.

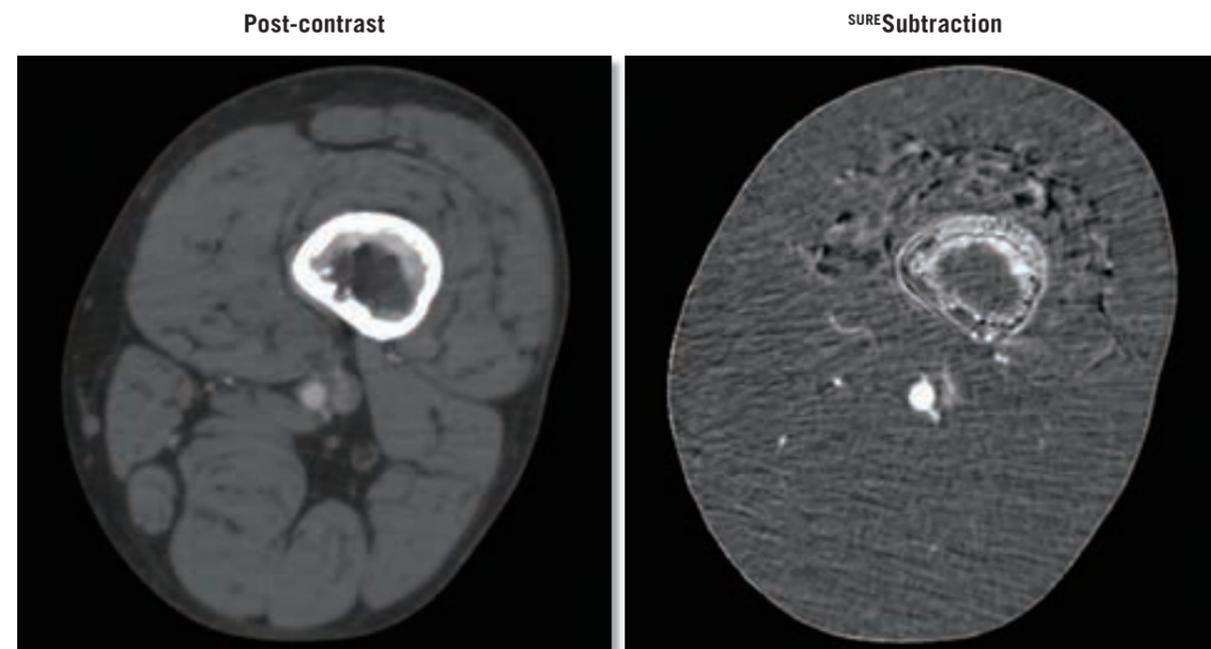
Paget's Disease

Patient History

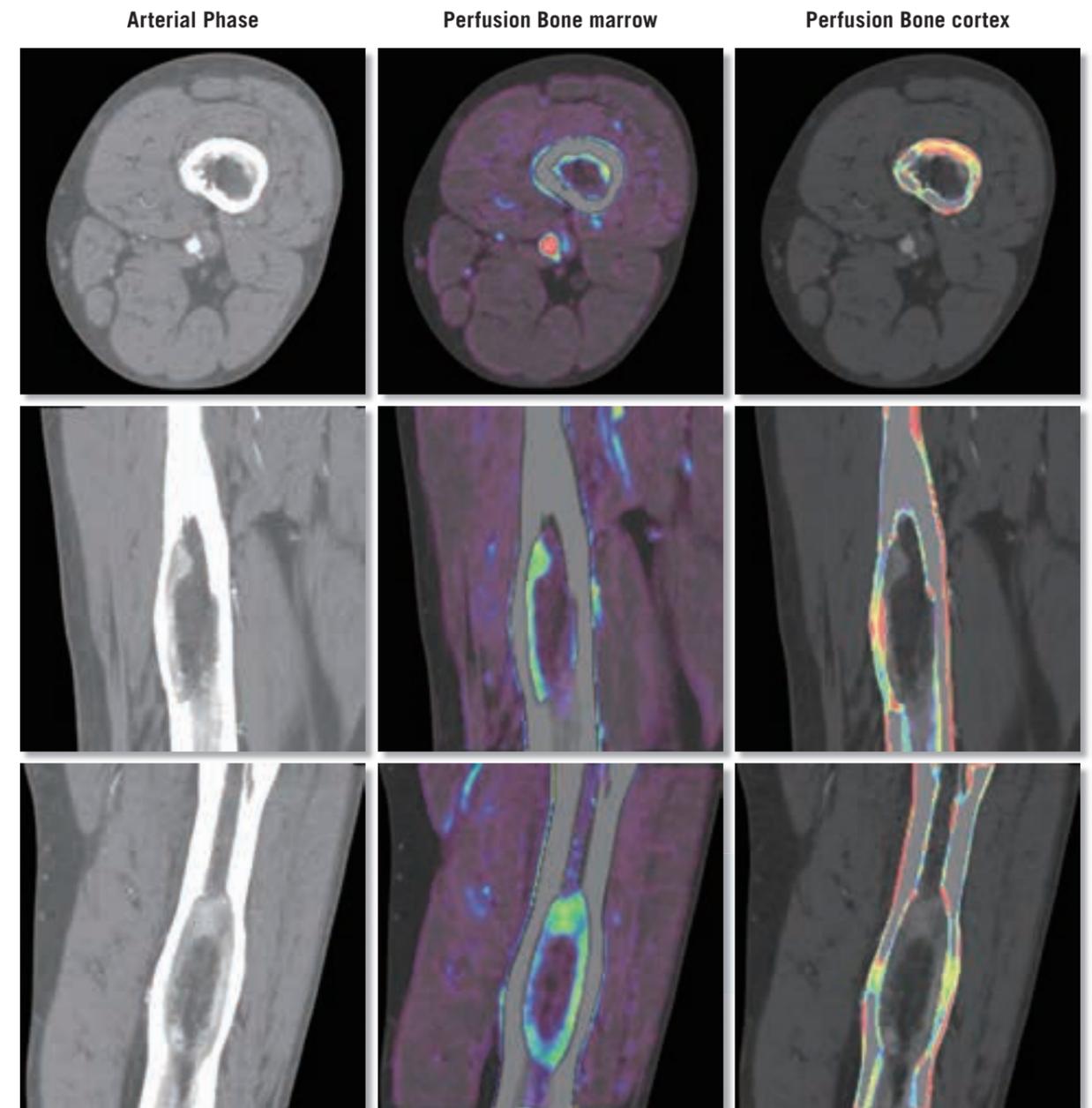
This 60-year-old man was referred for a CT scan to evaluate a lytic lesion of the distal femoral diaphysis. He also has pagetic bone changes of the proximal femur.

Scan protocol

Dynamic intermittent scanning was performed during the injection of intravenous contrast agent. Scanning was performed for 105 seconds to capture the pre-contrast, arterial, and venous phases. Perfusion analysis using the maximum slope analysis technique was performed to visualize the blood flow in the lesion.



The subtracted late arterial-phase image clearly demonstrates the enhancement of the bone cortex, which is impossible to appreciate in the non-subtracted image.



Conclusion

CT Perfusion demonstrates enhancement of the subcortical rim of the distal femur and associated enhancement of the cortical bone, characteristic of focal Paget's disease.

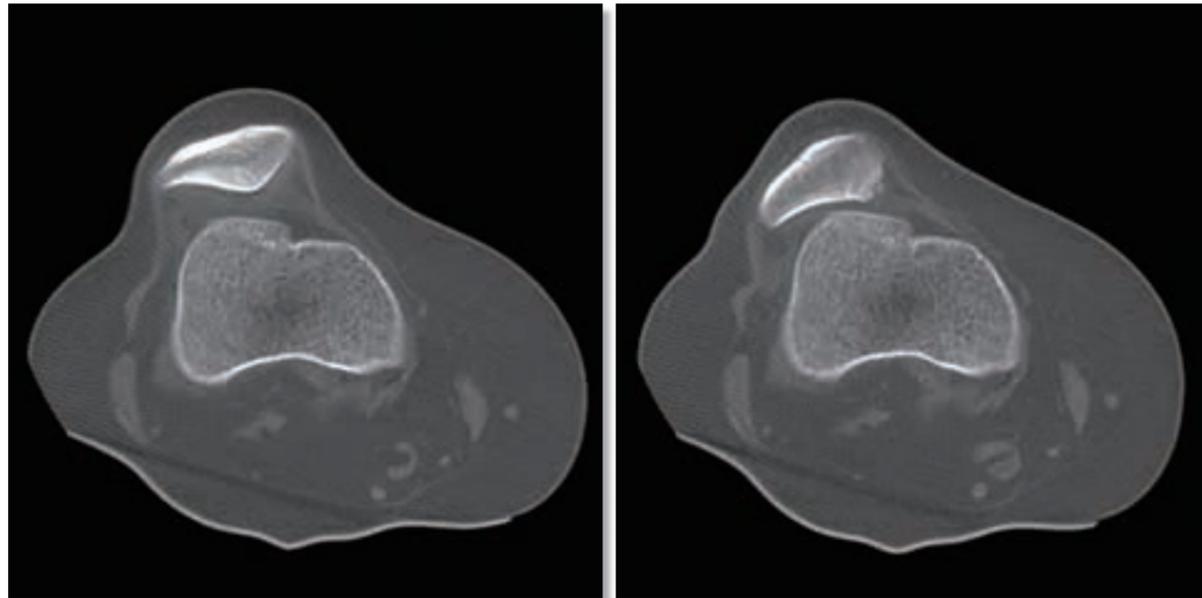
Patello-Femoral Instability

Patient History

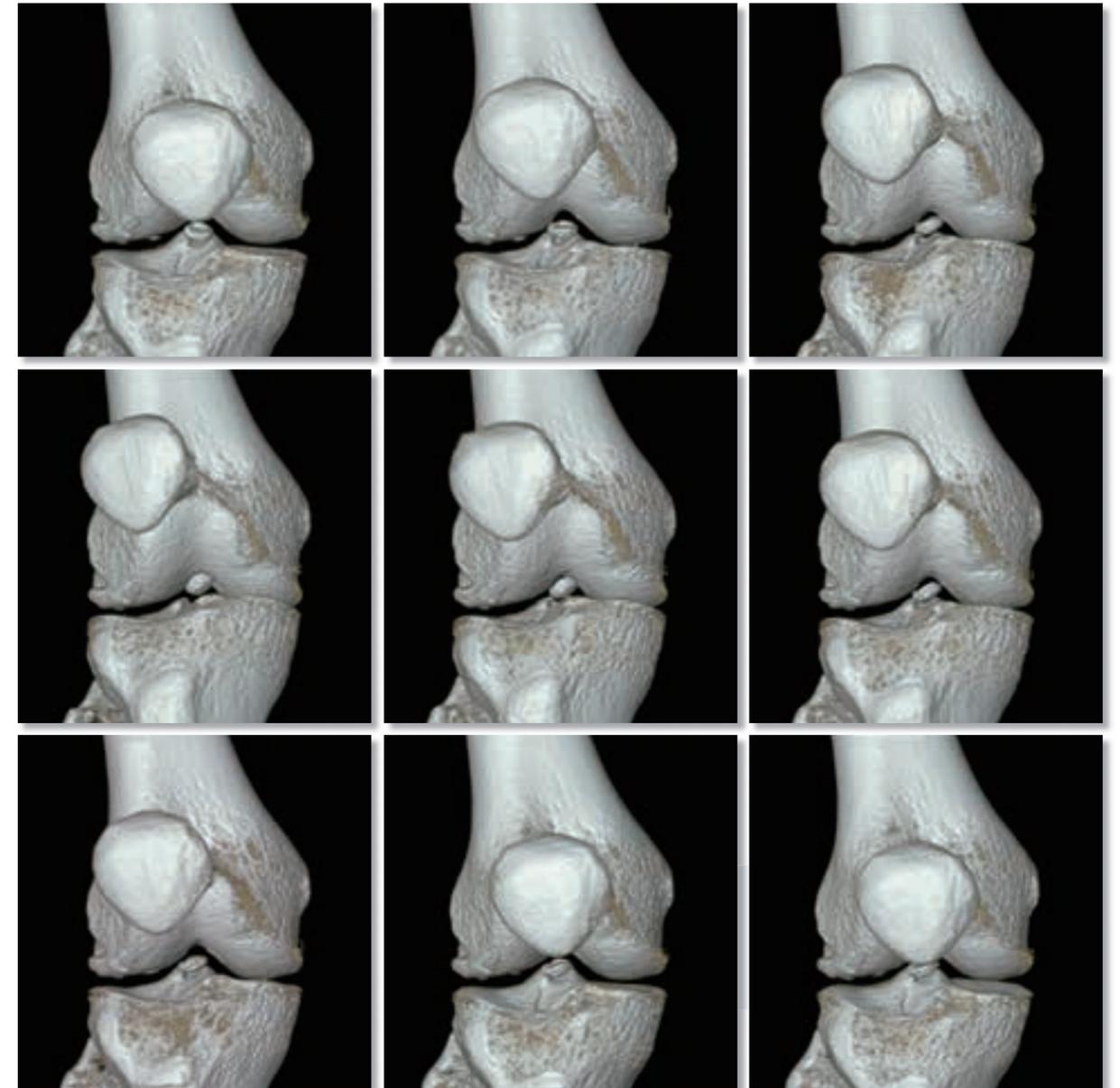
This 22-year-old woman presented with anterior knee pain and a history of locking during knee extension.

Scan Protocol

Intermittent dynamic scanning was performed during flexion-extension of the knee. The total scan time of 10 seconds captured one full flexion-extension cycle.



Images of the knee in maximum flexion and extension demonstrate lateral displacement of the patella in flexion.



Conclusion

Dynamic CT study of the patello-femoral engagement shows an abrupt lateral displacement of the patella in the first degrees of knee flexion (J-sign), confirming patello-femoral instability.

Additionally, an osteochondral fragment secondary to an osteochondritis dissecans lesion of the medial femoral condyle is seen in the intercondylar groove.

Vascular Malformation of Knee

Patient History

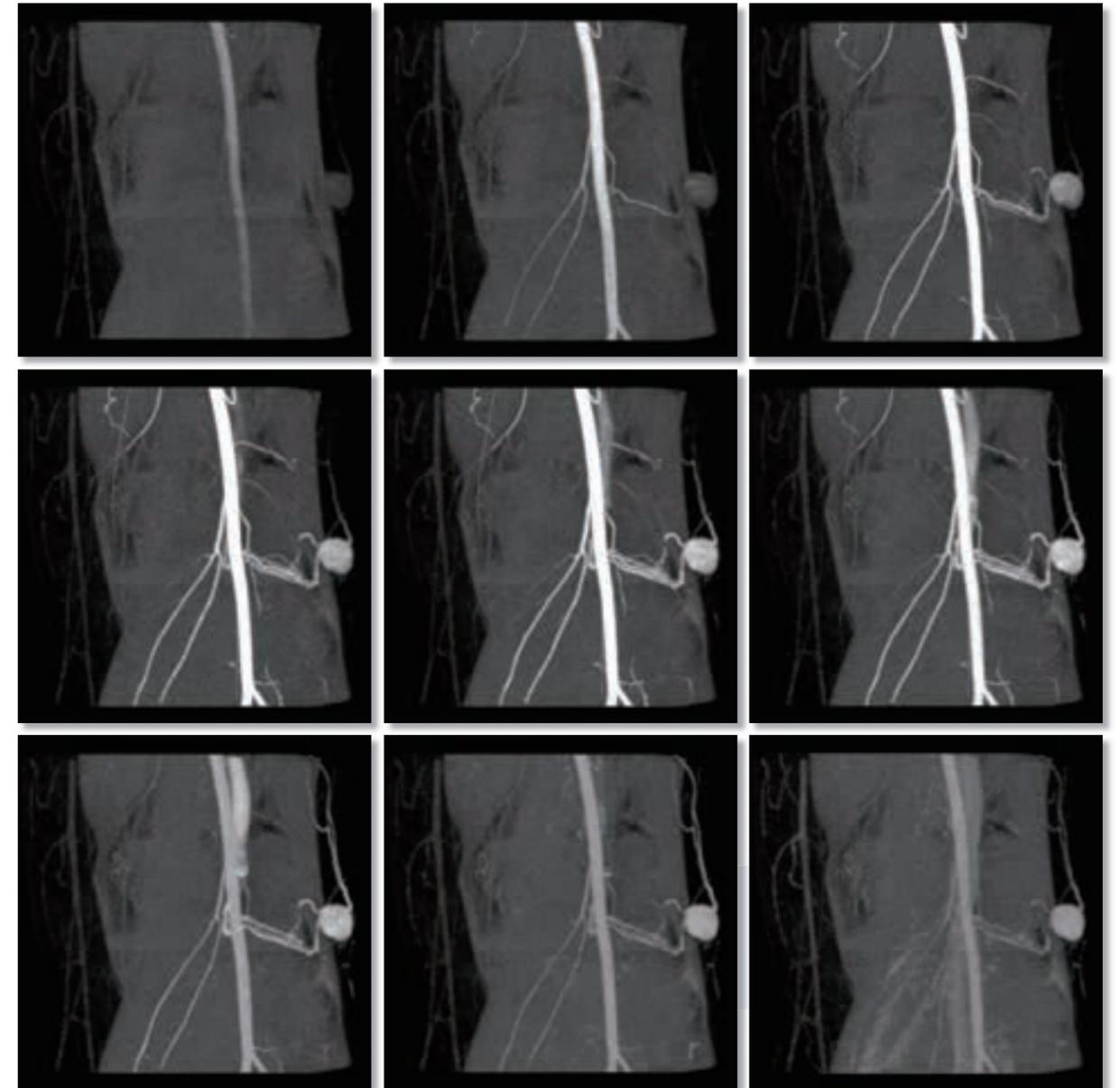
This 54-year-old woman presented with a known vascular malformation of the right knee. A dynamic CT scan was requested for preoperative evaluation.

Scan Protocol

Dynamic intermittent scanning was performed during the injection of intravenous contrast agent to capture the arterial and venous flow through the AVM.



The AVM is clearly demonstrated in these posterior and lateral volume-rendered images.



Conclusion

Dynamic CT angiography confirms the presence of a high-flow vascular malformation lateral to the knee joint. The study also demonstrates early enhancement of the lesion, which is fed mainly by the inferior geniculate artery.

An arteriovenous shunt is identified in this lesion, represented by fast venous return and precocious filling of the popliteal vein.