Orthopedic Hardware Imaging

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Outline

• Part 1: Overview and radiography
• Part 2: CT
• Part 3: MRI

Part 1

Hardware image overview and Radiography

Overview

• Key point:
  - Radiography is the foundation of hardware imaging
    • Pre-op planning
    • Immediate post-op
    • Surveillance
    • Symptom evaluation
Radiography

Example Cases

Left hip pain, pre-replacement
Preoperative planning

Initial postoperative

Initial postoperative

What can we miss on AP view only?

Initial postoperative

Postop revision

Immediate post-operative, total hip replacement
Intra-operative fracture

If there is any doubt...

Radiography

- Surveillance and symptom investigation
- What can go wrong?
  - Hardware
    - Breakage, loosening, migration
  - Bone
    - Malunion, fracture, necrosis, lysis
  - Joint
    - Infection, degeneration
  - Soft tissue
    - Hardware debris, heterotopic bone, fluid collection, mass

Additional view

Elbow trauma

Immediate post op

Back to the OR...
Hardware failure

Loosening and migration

Hardware failure?

Broken!

Mysterious “popping” hip

Bone complications

Follow up total hip

Redo Lowenstein
Broken bone!

Show entire hardware implant, plus adjacent bone!

Left hip pain, chronic complex cyst

Fracture

Remember the radiographs!

End of part 1!

I love metal hardware!

Part 2
CT imaging of hardware
Rule-out fracture?

Metal artifacts
- Streaks
  - Photon “starvation” and noise
  - “Beam hardening”
- Solution??
  - Higher kVp
  - Higher mAs
  - Lower pitch
  - Monoenergy?
  - Virtually (dual-energy)
Metal artifacts

• Reconstruction
  – Less noise
  • Thicker slices
  • Smoother filter
  • Software algorithms?

• Streaks
  – Photon “starvation” and noise
  – “Beam hardening”

• Solution??
  – Higher kVp
  – Higher mAs
  – Lower pitch
  – Monoenergy?
  • Virtually (dual-energy)

Radiography to CT

• Surveillance and symptom investigation
  – Clinical suspicion when radiographs are normal
  – Radiographs prompt further characterization

• Potential complications
  – Hardware
    • Breakage, loosening, migration
  – Bone
    • Malunion, fracture, osteonecrosis, osteolysis
  – Joint
    • Infection, degeneration
  – Soft tissue
    • Hardware debris, heterotopic bone, fluid collection, mass
  – Vessels
    • Vascular injury

Hardware position?

Intra-articular screw
Hardware position?

Hardware position?

Hardware position?

Hardware position?

MTP Fusion?
MTP Fusion?

State-of-the-art

- Metal reduction software applications

Hip pain

Metal artifact reduction

Fracture

Metal artifact reduction

Standard

Metal reduction

Fracture

Warning
Proceed Carefully
Vascular injury (pseudoaneurysm)

State-of-the-art

- Spectral/dual energy CT
- Virtual monoenergy reconstruction

Monoenergy + Metal reduction

Metal artefact reduction in genstone spectral imaging dual-energy CT with and without metal artefact reduction software

Metal artefact reduction in genstone spectral imaging dual-energy CT with and without metal artefact reduction software

Figure 9: Monoenergetic CT and metal artefact reduction CT performed with a dual energy technique using 140- and 80-kVp spectra in the patient with left femur hardware. A reconstructed monoenergetic simulation at 140-kVp reduces artifact due to beam hardening.
State-of-the-art

- Iterative reconstruction

Noise

De-noise?

- Filtered Back Projection
- 1st Gen Iterative Recon
- 2nd Gen Iterative Recon

State-of-the-art

- 2D, 3D reconstruction
Figure 2 3D images with metal. An 85-year-old man sustained an intertrochanteric fracture of the right femur, which was subsequently fixed with a femoral nail and spiral blade and was shown radiographically (A). A CT was also performed. Maximum intensity projection (MIP) and volume rendering (VR) were obtained.

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End of part 2...