GUIDELINES FOR THE IMAGING OF THE TRAUMA PATIENT

NEW HAMPSHIRE
TRAUMA MEDICAL REVIEW COMMITTEE

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INTRODUCTION

CT scanning has markedly improved the clinician’s ability to diagnose and define the extent of injury in patients with multiple trauma. However, the indiscriminate use of multiple CT scans for all trauma patients not only adds cost to the health care system but potentially may increase cancer risks for the patient later on in life. ¹,² In addition, regionalization of trauma care has resulted in the need for patients to be transported from one hospital to another institution for the appropriate definitive care. CT scans that are incomplete, not properly formatted, or not sent with the patient create the need for repeated studies which add time, cost, and additional radiation exposure to an individual’s care.³

Developing an algorithm to define the extent of diagnostic imaging for the multiple scenarios associated with caring for trauma patients is beyond the scope of the New Hampshire Medical Trauma Review committee. However, this manual offers technical guidelines to serve as a starting point in performing trauma CT scans and offers principles and guidelines to help decisions about how and when scans should be done. In addition several clinical cases are offered which exemplify how a selective approach to diagnostic imaging may be employed.

This information is presented to serve as a common starting point for all hospitals caring for trauma patients and to lessen the need for repeat imaging for patients requiring transfer to a second hospital for further care.

PRINCIPLES AND GUIDELINES

Principle #1:
The fear of cancer risk from CT scans should never influence the appropriate radiologic evaluation of the trauma patient. CT scanning has never been shown to cause cancer but has saved many lives with its proper and appropriate use.

Principle #2:
If the need for transfer to another facility for definitive care is recognized early, all subsequent imaging should be limited to that which allows for a rapid, safe transport of the patient.

Diagnostic testing questions to ask:
Will it change management?
Is it dangerous for the patient?
Can the test be done correctly?
Will it delay transfer for definitive care?

Guideline #1:
Routine CT scan performed to evaluate for blunt abdominal trauma should always include IV contrast* but it is not necessary (or desired) to give enteral contrast (oral contrast administration creates a risk of aspiration and delays the duration of the scan). CT scan of the “abdomen” should always include the pelvis.

*The incidence of contrast induced nephropathy is extremely low.⁴ Waiting for serum BUN/Cr determinations should not delay CT scans with IV contrast in the seriously injured trauma patient. Special situations that may warrant caution are patients with pre-existing renal insufficiency, diabetes mellitus, taking Lasix or nephrotoxic drugs.
**Guideline #2:**
The minimum radiologic evaluation for a patient being transferred for definitive care with a severe mechanism of injury should include a chest x-ray and pelvis film.

**Guideline #3:**
All trauma imaging studies should include reconstructed images in the coronal and sagittal planes except those performed on the head. Significant additional information is obtained from these views. Coronal and sagittal reconstructions of all spine CT images are especially important and this does not require additional radiation dose or scanning time.

**Guideline #4**
If clinical suspicion for renal injury is high it should be remembered that delayed images in relation to the timing of the arterial bolus must be obtained to assess for urinary extravasation. Alternatively this could be accomplished with multiple timed contrast boluses.

**Guideline #5**
If a fracture is found at one level of the spine the entire spine should be imaged as the chance of a second fracture at a different level is 10-15%.

**Guideline #6**
All modern multi-detector CT scanners have automatic control of technical factors designed to minimize patient dose while maximizing image quality. Most also have the ability to render a lower dose for pediatric and young adult populations. Although the system "noise" produced is increased, and the resolution of the images at a point will decrease, they are still generally of diagnostic quality. One should generally utilize the manufacturers' recommendations with respect to technical factors (or use factors resulting in lower doses with acceptable diagnostic quality images) unless the change is made with a specific purpose in mind and the outcome is known to not adversely affect the patient. Breast shielding should be used in all female patients having chest or abdomen CT scans, unless it interferes with utilization of dose modulation programs.

**Guideline #7**
Hierarchical preference for Patient Images accompanying a transfer is as follows:
1. A properly formatted DICOM image set including a DICOM Part 12 compliant DICOMDIR file.
2. A properly formatted DICOM image set with an embedded image viewer
3. Patient images in other formats must include an embedded image viewer with brief instruction for use

Native DICOM images with a properly formatted DICOMDIR file will allow the recipient facility to utilize image viewing tools familiar to them, reducing treatment time and enhancing patient care.
CASE HISTORY EXAMPLES

Case Study 1:

- 23 year old woman who was the restrained driver in a MVC rollover
- EMS report -> awake and alert, no LOC, GCS = 15
- Arrives boarded and collared at the ED 45 minutes after crash
- Vital Signs
  - BP 110/82   P= 95   RR = 22   GCS = 15
- PE:
  - Head = abrasion over the right frontal area
  - Chest = tenderness over the left clavicle; BS equal
  - Abdomen = soft, non distended; abrasion over the lower abdomen
  - Pelvis = stable, no pain
  - Extremities = deformity to right wrist
  - Neuro = intact
- Do you have the appropriate imaging tools to provide the proper studies?
- Do you have available resources to care for the injuries you might find?
- What studies would define injuries requiring immediate attention / stabilization?
- If no serious injuries would the patient be admitted anyway?

**Diagnostic Imaging:**
CXR, left clavicle, right wrist plain films, FAST
Admit for observation
Case Study 2:

- 32 year old male involved in high speed MCC. Initially unconscious at the scene, now combative and posturing for EMS.
- Arrives boarded and collared
- Vital Signs
  - BP 100/85  P = 115  RR = 28  O2 Sat = 95%  GCS = 7
- P.E.
  - Head = 8 cm laceration over the left parietal area, bleeding. Pupils midpoint. GCS = 7
  - Chest = diminished BS on the left
  - Abdomen = soft, not distended, abrasions on LLQ
  - Pelvis = abrasion and ecchymosis over left anterior iliac spine. Movement of pelvis with compression
  - Extremities = deformity and swelling of the left thigh

- If the decision is made to transfer… priorities change!
  - Do not need to define every injury
  - Need to identify injuries you can help treat or stabilize to make transfer safer.

Diagnostic imaging and treatment
  - CXR, pelvis, right femur plain films
- Intubate
- Chest tube
- IV access
- Pelvic binder
- Traction splint
- Transfer ASAP!!
TRAUMA PATIENT TRANSFERS:

PLEASE SEND DICOM IMAGES WITH PATIENT TO RECEIVING TRAUMA CENTER
TRAUMA HEAD

LANDMARK: OMBL
SCOUTS: AP AND LATERAL

RECON 1:

START POINT: JUST BELOW BASE OF SKULL
END POINT: JUST ABOVE TOP OF HEAD
ANGLE: ANGLE TO OML
DFOV: 22
KV: 140
MA: 170
THICKNESS: 5MM (4i)
INTERVAL: 5MM
ALGORITHM: STANDARD (Axials only)

RECON 2:

ALGORITHM: BONE
THICKNESS: 5MM (4i)
INTERVAL: 5MM
C-SPINE

LANDMARK: STERNAL NOTCH
SCOUTS: AP AND LATERAL

AXIAL RECON 1:

START POINT: JUST ABOVE BASE OF SKULL
END POINT: STERNO-CLAVICULAR JOINT
ANGLE: NONE
SFOV: LARGE BODY
DFOV: 12
KV: 140
MA: 380
THICKNESS: 1.25MM
INTERVAL: 0.600MM
ALGORITHM: BONE

REFORMATS: SAGITTAL, AXIAL, AND CORONAL

\
AXIAL RECON 1:
C-SPINE REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
TRAUMA CHEST / ABDOMEN / PELVIS

LANDMARK: STERNAL NOTCH
SCOUTS: AP AND LATERAL
IV CONTRAST: 110ml OMNIPAQUE (non-ionic contrast)
IV SIZE: 20 GAUGE OR 18 GAUGE
INJECTION RATE: 3-4ml PER SECOND

RECON 1:

(GROUP 1)
START POINT: JUST ABOVE APICES
END POINT: THROUGH THE BASE OF THE LUNG
DFOV: DEPENDANT ON PATIENT
KV: 120
MA: AUTO MA TO 240
PREP GROUP: 30 SECONDS
THICKNESS: 2.5MM
INTERVAL: 1.25MM
ALGORITHM: STANDARD

(GROUP 2)
START POINT: BASE OF THE LUNGS
END POINT: THROUGH THE SYMPHYSIS PUBIS
DFOV: DEPENDANT ON THE PATIENT
KV: 120
MA: AUTO MA TO 440
PREP GROUP: 60 SECONDS
THICKNESS: 5.0MM
INTERVAL: 5.0MM
ALGORITHM: STANDARD

RECON 2: (LUNG)
START POINT: JUST ABOVE APICES
END POINT: THROUGH THE BASE OF THE LUNG
DFOV: SAME AS RECON 1
ALGORITHM: LUNG
THICKNESS: 5.0MM
INTERVAL: 5.0MM

RECON 3: (T/L SPINE)
START POINT: JUST ABOVE APICES
END POINT: S2
DFOV: 16-18 (PT DEPENDANT)
ALGORITHM: BONE
THICKNESS: 2.5MM
INTERVAL: 1.25MM

RETRO RECONS: RETRO RECON THE WHOLE SCAN (CHEST, ABDOMEN AND PELVIS) INTO THINS (1.25 THICK BY 0.625 SPACING) SO THAT REFORMATS MAY BE DONE

REFORMATS:
- AXIAL, CORONAL AND SAGITTAL OF THE CHEST, ABDOMEN AND PELVIS
- AXIAL, CORONAL AND SAGITTAL OF THE T-SPINE
- AXIAL, CORONAL AND SAGITTAL OF THE L-SPINE
CHEST / ABDOMEN / PELVIS REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
T-SPINE REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
L-SPINE REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
TRAUMA ABDOMEN/PELVIS

LANDMARK: XYPHOID
SCOUTS: AP AND LATERAL
IV CONTRAST: 110CC OMNIPAQUE
IV SIZE: 20 GAUGE OR 18 GAUGE
INJECTION RATE: 3-4CC PER SECOND

RECON 1:
START POINT: BASE OF THE LUNGS
END POINT: THROUGH THE SYMPHYSIS PUBIS
DFOV: DEPENDANT ON THE PATIENT
KV: 120
MA: AUTO MA TO 440
PREP GROUP: 70 SECONDS
THICKNESS: 5.0MM
INTERVAL: 5.0MM
ALGORITHM: STANDARD

RECON 2:
THICKNESS: 1.25MM
INTERVAL: 0.625MM
ALGORITHM: STANDARD

RECON 3:
START POINT: T12
END POINT: S2
DFOV: 16-18 (PT DEPENDANT)
ALGORITHM: BONE
THICKNESS: 2.5MM
INTERVAL: 1.25MM

REFORMATS:
- AXIAL, CORONAL AND SAGITTAL OF THE ABDOMEN AND PELVIS
- AXIAL, CORONAL AND SAGITTAL OF THE L-SPINE
ABDOMEN / PELVIS REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
L-SPINE REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
CYSTOGRAM

LANDMARK: ILIAC CREST
SCOUTS: AP AND LATERAL

RECON 1:
START POINT: ABOVE THE CREST
END POINT: BELOW THE SYMPHYSIS PUBIS
ANGLE: NONE
DFOV: DEPENDANT ON PATIENT
KV: 120
MA: AUTO MA TO 440
THICKNESS: 5.0MM
INTERVAL: 5.0MM
ALGORITHM: STANDARD

RECON 2:
ALGORITHM: STANDARD
THICKNESS: 1.25MM
INTERVAL: 0.625MM

1. SCAN THE PELVIS (IF SCANNING A CHEST/ABDOMEN/PELVIS TRAUMA SCAN, SKIP TO #2)
2. GRAVITY FILL THE BLADDER WITH NO MORE THAN 300CC DILUTE CONTRAST) AND SCAN THE PELVIS AGAIN.

CYSTOGRAM CONTRAST:
- CYSTOGRAFFIN 14% SOLUTION: MIX 30CC CYSTOGRAFIN PER 250CC SALINE BOTTLE (280CC TOTAL)
- OMNIPAQUE 350: MIX 15CC OMNIPAQUE PER 250CC SALINE BOTTLE (265CC TOTAL)
CYSTOGRAM REFORMATS:

CORONAL REFORMAT AREA:

SAGITTAL REFORMAT AREA:
FACIAL BONES

LANDMARK: OMBL
SCOUTS: AP AND LATERAL

RECON 1:

START POINT: JUST BELOW MANDIBLE
END POINT: JUST ABOVE FRONTAL SINUSES
ANGLE: ANGLE TO FACE
DFOV: 18
KV: 140
MA: 135
THICKNESS: 1.25MM
INTERVAL: 0.600MM
ALGORITHM: BONE

RECON 2:

ALGORITHM: STANDARD
THICKNESS: 0.625MM
INTERVAL: 0.625MM

REFORMATS: AXIAL, SAGITTAL AND CORONAL
FACE REFORMATS:

CORONAL REFORMAT AREA:
BIBLIOGRAPHY


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