Hampton Symposium, October 16th, 2010

Advances in Emergency Imaging

Robert A. Novelline, MD
Professor of Radiology, Harvard Medical School
Director of Emergency Radiology, Massachusetts General Hospital
Outline:

Advances in Emergency Imaging

1. Recognition as a radiology subspecialty
2. Explosive growth MGH ED cross-sectional imaging
3. Redesign MGH Emergency Imaging Division
4. MGH Emergency Imaging technical advances
Subspecialty Emergency Radiology

Definition:
“The imaging & imaging management of acutely ill and injured patients”

Responsibilities:
Imaging of ED patients as well as off-hours imaging of all patients

One the newest radiology subspecialties

Currently 5 USA Emergency Radiology fellowship programs

Subspecialty Society: American Society of Emergency Radiology (ASER)
Founded in Boston in 1988, currently over 400 members
ASER Resident Core Curriculum in Emergency Radiology

Journal: Emergency Radiology

Refresher/Instructional Courses in Emergency Radiology at RSNA/ARRS
Increasing Importance of Emergency Imaging in the USA

• US population is just over 300 million
• 2006 survey: 119.2 million US ED visits
  – Trauma-related visits: 42.4 million
  – Percent of visits resulting in admission: 13%
• Volume in US ED’s increasing 2- 5% per year
• Nationally an average of one imaging exam for every emergency department visit
• Estimated today 20-30% of ED imaging with CT
Changes in Imaging Expectations for ED Patients

- In the past, emergency imaging was a plain film operation
  - Today, CT, US and MR are routine
- In the past, complex patients were admitted and imaged later
  - Today diagnostic imaging is performed while the patient is in the ED
  - Results determine whether admission occurs and to which service
  - Results may indicate emergency surgery
- Today emergency physicians demand on-line imaging and on-line interpretation of ED patients at all hours
- MGH Emergency Imaging staffed 24/7 with staff radiologists
2. Explosive Growth of MGH Emergency Imaging
MGH Emergency Department volume increases 2-3% per year
Period of increased image utilization: 1997 to 2003
Image growth greater than growth in patient visits
Period of image usage stabilization: 2003 to 2009
Image growth parallel to growth in patient visits
Explosive Growth of Emergency CT
Volume of Commonly Ordered CT Exams

- ABDOMEN & PELVIS
- HEAD
- CHEST
- CERVICAL SPINE

Utilization C-Spine Trauma Imaging 1992-2008

- **plain films**
- **CT**

The graph shows the utilization of C-Spine trauma imaging from 1992 to 2008. The x-axis represents the years, and the y-axis represents the number of imaging procedures. The line graph compares the usage of plain films and CT scans over the years.
Pulmonary Embolism Studies

- CT PE
- V/Q Scans
- PulmArt

Plot Area
3. Redesign of Emergency Imaging
Architectural Program for 2003 Renovation of MGH Emergency Imaging Division

3 Digital radiographic rooms
   1 dedicated chest unit
   2 multipurpose room
2 Multidetector CT scanners
1 Ultrasound room
1 MR scanner
Large consultation/reading room
Stretcher and ambulatory patient waiting areas
Technologist computer work area
Reception/scheduling desk
On-site manager’s office
MGH Emergency Radiology
Reception; Patient Waiting
Two MDCT Scanners with Large CT Control Room

16-Slice

64-Slice
Restricted Access MR Suite
Consultation Room has 8 PACS Workstations and a 3D Workstation.
Plasma Screen PACS Monitor for Conferences and Work Rounds
4. MGH Emergency Imaging Technical Advances
Emergency Imaging Research Topics

- Facial Trauma CT utilization
- Aortic Dissection CT Utilization
- MDCT Classification of Le Fort Facial Fractures
- PE CT; Comparison with D-dimer in 1000 ED Cases
- Comparison of Chest Film and Chest CT in Trauma; 563 cases
- Value of Cervical Spine CT Soft Tissue Windows
- Role of Coronal and Sagittal Reformations in TL Spine Trauma
- CT of Bowel Ischemia
- CT of Epiplolic Appendagitis
- MR of Pregnant Patients with Suspected Appendicitis
- MR of Children with Suspected Appendicitis
- CT of Bladder Trauma; Role of Multiplanar Reformations
- CT of Soft tissue injuries of the Orbit
- Role CT Sagittal Reformations in Facial Trauma
Innovations by MGH Emergency Imaging

1. Developed the total body trauma scan
2. Pioneered volumetric trauma imaging
3. Volumetric estimation of pneumothorax size
4. Advances in imaging the acute abdomen
   • Appendicitis, diverticulitis, epiploic appendagitis
The “Total Body” Trauma Scan

- First described in 2001 ASER (RSNA 2002) and first reported by the MGH Emergency Imaging
- Made possible with advent of helical scanning and significantly improved with MDCT
- Permits rapid imaging of the head, spine, chest abdomen and pelvis in the multiple trauma patient; continued on to include
- Excellent multiplanar and volumetric reformations for evaluation of complex injuries


* Ptak T, Rhea J, Novelline RA, Radiation dose is reduced using a single-pass whole-body trauma protocol as compared to a conventional segmented imaging method. Radiology, December 2003 229:902-905
Why a total body trauma scan?

- Location of fatal injuries
  - 40% from head injuries
  - 25% from chest injuries
  - 10% from abdominal injuries
  - 20% related to spine trauma

- “Total Body” MDCT scan
  - Scan from vertex of head through pelvis can evaluate for injuries in these four areas in a quick 2-4 minute single acquisition CT scan
  - Not for everyone; indicated for the polytrauma patient
“Total Body” Trauma Scan Protocols

- Recommendation: 16 slice or greater MDCT scanner
- Use IV contrast material for chest, abdomen, pelvis
- Routine oral contrast not needed today
  - Triple contrast (oral, colon, IV) for penetrating injuries
- If suspected carotid/vertebral injury, scan head/neck with IV contrast after non-contrast head scan
- Continue scan as a run-off for lower extremity injury
- Delayed scan for positive parenchymal organ injury
- CT cystogram for suspected bladder rupture
Volumetric Trauma Imaging
Volumetric Trauma Imaging

• MGH Emergency Imaging has pioneered and promoted volumetric trauma imaging
• 3D workstation in reading room available for 24/7 volumetric, MIP, curved plane, perfusion and other MDCT reformations
Depressed Skull Fracture
Volume Rendered
Depressed Skull Fracture
Displaced Zygoma Complex Fracture
Volume Rendered Displaced ZMC with Frontal Fracture
Child with Pencil Foreign Body in Left Orbit

VR Bone Shows Only Pencil Graphite Center
VR Soft Shows Entire Pencil
Capsular Ligament Disruption on 3D
Aortic Injury
Multiple Trauma
Volumetric Images Aortic Trauma
Subclavian Artery
Traumatic Occlusion
Pelvic Fractures in MVC
Volumetric Reformations
Measuring Pneumothorax Size

How Big are They?

Right PNX is 496cc; Left PNX is 53.5cc
Advances in Imaging the Acute Abdomen
Appendiceal Imaging

- Developed an MDCT appendiceal imaging protocol utilizing IV & rectal contrast associated with 99% accuracy
- Reported that the routine use of appendiceal CT would decrease unnecessary surgery and cut health care costs

*Rao PM, Rhea JT, Novelline RA, Mostafavi AA, McCabe CJ. Effect of computed tomography of the appendix on treatment of patients and use of hospital resources. NEJM. 1998;338(3):141-146
Promoted the Use of MR for Suspected Appendicitis in Pregnant Patients
Investigated MDCT of Diverticulitis

Frequency of findings of diverticulitis*

- Paracolonic fat stranding 100%
- Diverticula 97%
  • With or without fecalith
- Focal colon wall thickening 94%
  • Greater than 5mm
- Muscular hypertrophy 90%
- Free air 21%
- Abscess/phlegmon 21%
- Free fluid 8%

*Kircher MF, Rhea JT, Kihiczak D, Novelline RA. Frequency, Sensitivity, and Specificity of Individual Signs of Diverticulitis on Thin-Section Helical CT. AJR 2002; 178:1313-1318
Described the CT Appearance of Epiploic Appendagitis

Paracolic 1-4 cm oval fat density surrounded by inflammatory fat stranding

Inflammation is para-colonic rather than peri-colonic

May be slightly denser than normal fat and have a central blood vessel density

May show adjacent bowel wall thickening
Described the Evolution of Epiploic Appendagitis

Day 0

3 Months
Summary

• Emergency Imaging has grown in volume and sophistication with increased emphasis on cross-sectional imaging
• Expectations are for high quality imaging and on-line interpretation 24/7
• Current standards of care require optimal technologies for emergency imaging
Thank You for Your Attention!

Robert A. Novelline, MD
Professor of Radiology, Harvard Medical School
Director of Emergency Radiology, Massachusetts General Hospital

novelline.robert@mgh.harvard.edu