Paediatric FORENSIC imaging

Owen Arthurs
Consultant Paediatric Radiologist
GOSH, London UK
PM imaging in NAI

• Above / beyond skeletal surveys

• Where can cross-sectional imaging be useful?

• CT vs MR
  • Fracture identification – is CT better than XR?
  • Problem solving – additional details from CT / MR
  • Imaging for the court – 3D reconstructions
  • Where does it NOT help?
  • Specific / case examples

• Recent research on post mortem imaging in children
All imaging in context

• Clinical history
• Clinical Examination
• Blood tests and microbiology

• Imaging – XR, CT, MRI

• Additional investigations
• Autopsy – pathological samples
• Genetic / other tests

• Family and social circumstances
• Previous medical or social history
• Police and psychiatric reports
What do we know already?

- Skeletal surveys – occult fractures common
- Brain injury common in NAI – CT head guidelines
- Abdominal trauma not uncommon
- No guidelines on body imaging in NAI?
- Similar to trauma / RTA
Brain Injury in NAI

- Subdural haematoma 86%
- Retinal haemorrhage 76%
- Cerebral oedema 42%
- Skull fracture 25%
- Associated rib fractures 22%

- 20% mortality
- 50% survivors have moderate / severe disability

- Head imaging in all < 1 yr

- >50% of infants < 1 year with fatal brain injury have no external evidence of trauma
CT vs MRI in NAI

- Consider MRI early esp - retinal haemorrhages (80% of NAI)
Abdominal trauma?

- Guidelines on use of CT for abdominal trauma / RTA?

- Guidelines on use of CT in NAI

13. Abdominal and thoracic injuries

13.1 Children who have been abused may suffer other forms of injury, including trauma to the chest and abdomen.

13.2 The overriding clinical responsibility is the diagnosis and treatment of the presenting clinical injury.

13.3 The investigation of thoracic and abdominal injuries in suspected NAI should be no different from the imaging used for accidental trauma.

13.4 Contrast enhanced CT is the imaging modality of choice for both the abdomen and chest, although the whole gamut of cross-sectional imaging may be employed in certain circumstances. If a head CT is being undertaken at the same time, this should be performed prior to the chest and abdomen and prior to the administration of contrast.

13.5 In some circumstances, ultrasound may be used to evaluate the abdomen as an adjunct to CT.
Abdominal injuries in NAI

- Blunt trauma
  - Punch / kick
  - Rapid deceleration from being thrown

- Mean age 2 years, commoner in males
- 5% of abdominal injuries in children are due to NAI
- Counts for up to 20% of abuse fatalities

- If in doubt, do a CT!
Body CT in RTA?
Body CT in RTA?
Body CT in RTA?
Body CT in RTA?
Who to CT?

- Suspected high velocity injuries
- Multiple rib fractures
- Subtle radiographic findings
- To illustrate 3 dimensional injuries better
- When something is not quite right?

What have I learnt from PM imaging?
Why would we CT?
CT to problem solve
Rib fractures in SUDI

Resuscitated, no NAI

Weber M et al., 2009
Rib fractures in NAI

Rib fractures + other features of NAI

Weber M et al., 2009
CT vs XR for rib fractures

Value of postmortem thoracic CT over radiography in imaging of pediatric rib fractures

Terence S. Hong · Jeanette A. Reyes · Rahim Moineddin · David A. Chiasson · Walter F. Berdon · Paul S. Babyn

Results Primary interpretation: Fractures were recognized on radiography in 5/12 patients who had fractures found at autopsy, and on CT in 8/12 patients. In total, 29% (24/83) of fractures were reported on radiography, and 51% (52/101) of fractures were reported on CT. Study radiologist: Fractures were recognized on radiography in 7/12 patients who had fractures found at autopsy, and on CT in 11/12 patients. In total, 46% (38/83) of fractures were reported on radiography, and 85% (86/101) of fractures were reported on CT.

Conclusion Postmortem thoracic CT provides greater sensitivity than radiography in detecting pediatric rib fractures, most notably in anterior and posterior fractures. However, the degree of improvement in sensitivity provided by CT might depend on observer experience.
CT vs XR for rib fractures
Does CT always help?
Who needs an MRI?

- Soft tissue injury?

- Internal organ injury?
  - Lungs
  - Liver
  - Spleen
  - Renal

- Problem solving
PM MR

• See fractures, and soft tissue injury
MSK errors on PMMR
Forensic imaging

- Awareness of limitations of conventional radiographs
- Fractures can be hard to spot!

- Head CT as per guidelines

- If body injuries or suspicion in NAI, use CT
  - Further characterizes fractures and patterns
  - Soft tissue injuries
  - Role of MRI unclear in live patients

- If deceased
  - Plain radiographs in first instance
  - Whole body PM CT for bony detail
  - PM MRI for soft tissue abnormalities
Latest research

- Understanding post mortem interval
- Incidental findings from PM imaging:
  - E.g. IO needle placement
- Micro CT for CMLs
PM change – DWI

Live $T_2w$  

PM DWI

Arthurs OJ et al., 2014
Intra-osseous needles

Jawad et al., 2015
Intra-osseous needles

Jawad et al., 2015
High-resolution CT with histopathological correlates of the classic metaphyseal lesion of infant abuse

Andy Tsai · Anna G. McDonald · Andrew E. Rosenberg · Rajiv Gupta · Paul K. Kleinman
Summary

• Awareness of limitations of conventional radiographs
• Fractures can be hard to spot!

• Head CT as per guidelines

• If body injuries or suspicion in NAI, use CT
  • Further characterizes fractures and patterns
  • Soft tissue injuries
  • Role of MRI unclear in live patients

• If deceased
  • Plain radiographs in first instance
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THANK YOU

owen.arthurs@gosh.nhs.uk