

NAME 2019:

Postmortem CT in Blunt Accidental Trauma and Suspected Elder Abuse

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Applications of PMCT

- Blunt trauma
- Penetrating trauma
- Unidentified body
- Suspected NAI in young children
- Suspected Elder abuse
- Drowning
- Decomposition
- Burns
- Unknown cause of death
- Suicide
- Contraband
- Anthropology
- Historical Investigations

Recent Advances in Forensic Radiology

Background

Recent studies have suggested a major potential role for high-resolution whole body CT scans in the forensic investigation of death following accidental trauma



C 3-4 fracture dislocation
overlooked at Autopsy due to
severe rigor mortis



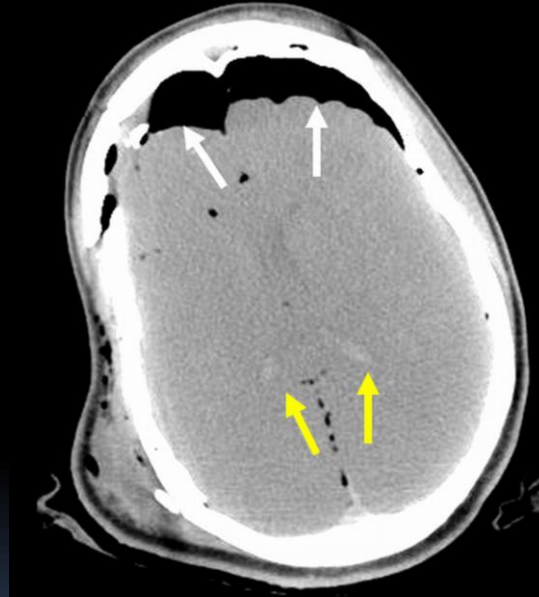
Can Postmortem CT match the Traditional Autopsy for Blunt Accidental Trauma ?



How Reliable is PMCT in fatal Blunt Trauma?

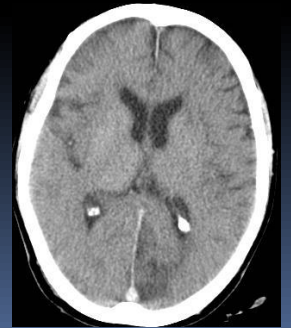
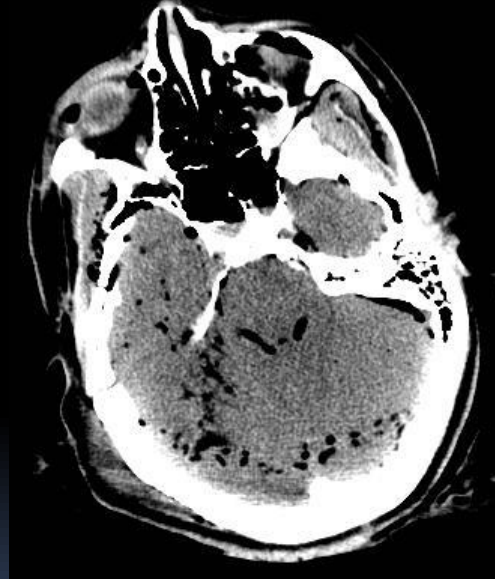
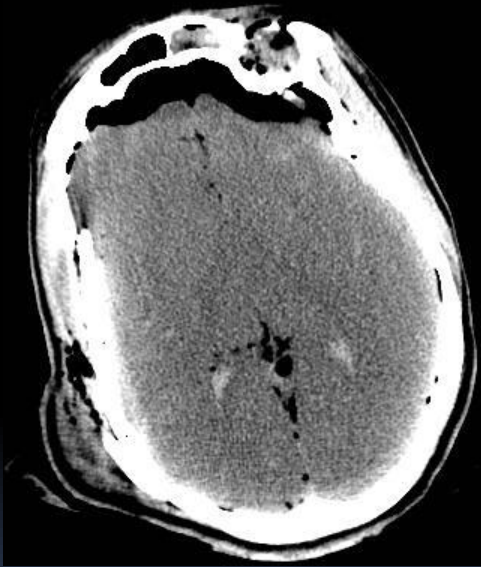
- Comparison of Whole Body Postmortem 3D CT and Autopsy Evaluation in Accidental Blunt Traumatic Death using the Abbreviated Injury Scale (AIS) Classification. (Forensic Sci Int 2013)
 - PMCT exceeds the sensitivity of Autopsy for detection of major blunt accidental skeletal injuries classified grade 3-6 (serious-un survivable) on the AIS scale
- Post-mortem imaging compared with autopsy in trauma victims - a systematic review (*Forensic Sci Int* 2015)
 - 563 cases
 - PMCT is more sensitive than conventional autopsy in detecting skeletal injuries.
 - For soft tissue injuries, autopsy remains superior to imaging.
 - Aortic injuries are missed frequently by PMCT

Can PMCT augment or replace Traditional Autopsy in this setting?

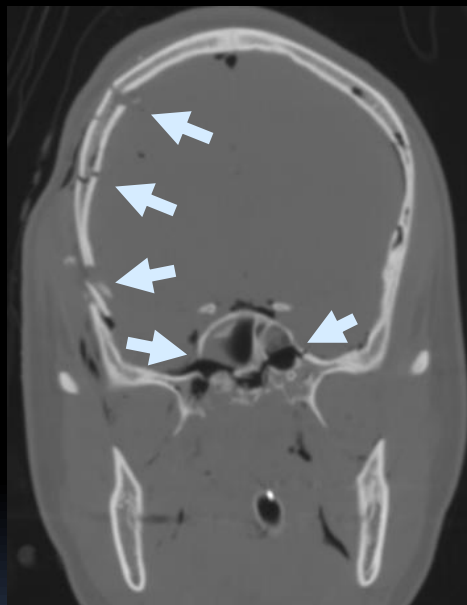


Case 1: Multiple skull fractures and severe diffuse brain injury

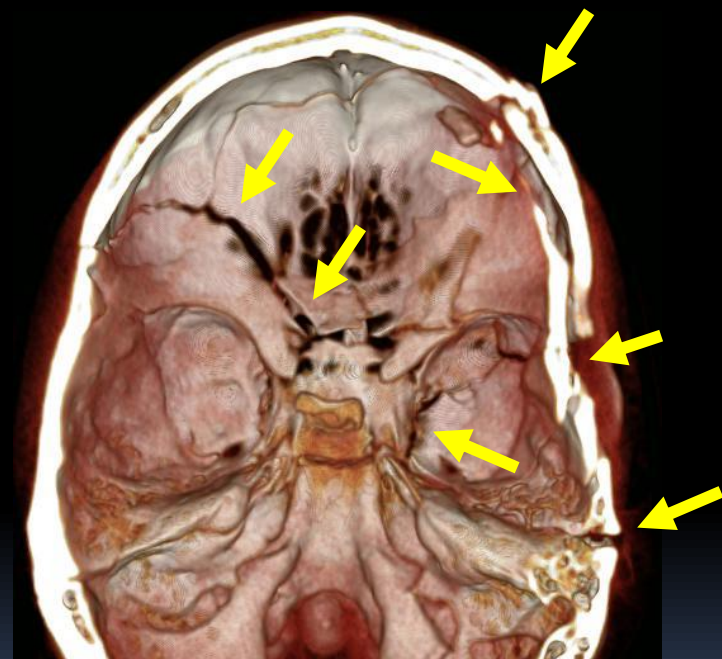
Case 2 : Multiple fractures, intracranial air and severe diffuse brain injury with intraventricular bleeding



Other views of fractures in this case

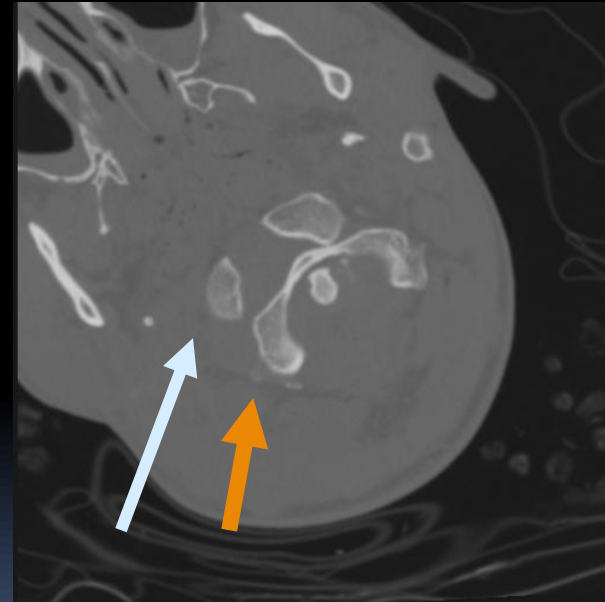
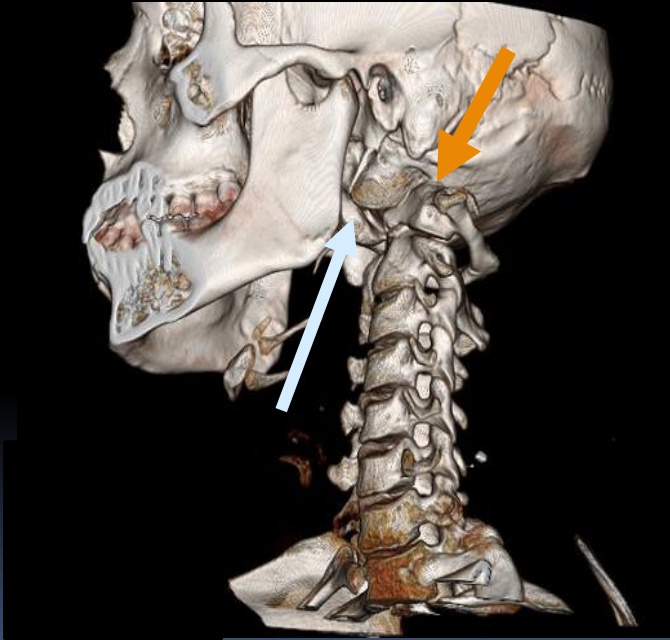


Coronal MPR view

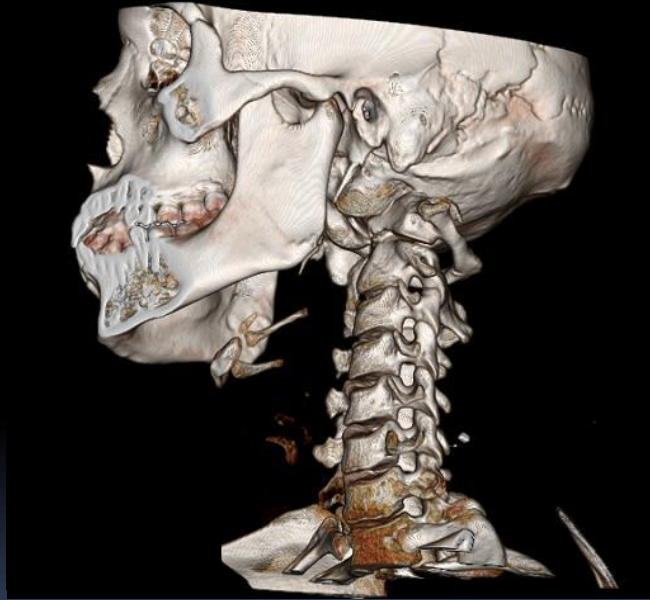


VR virtual dissection view

Case 3: Blunt Accidental Trauma: Rotational Atlanto-Occipital Dislocation



Rotational Atlanto-Occipital Dislocation

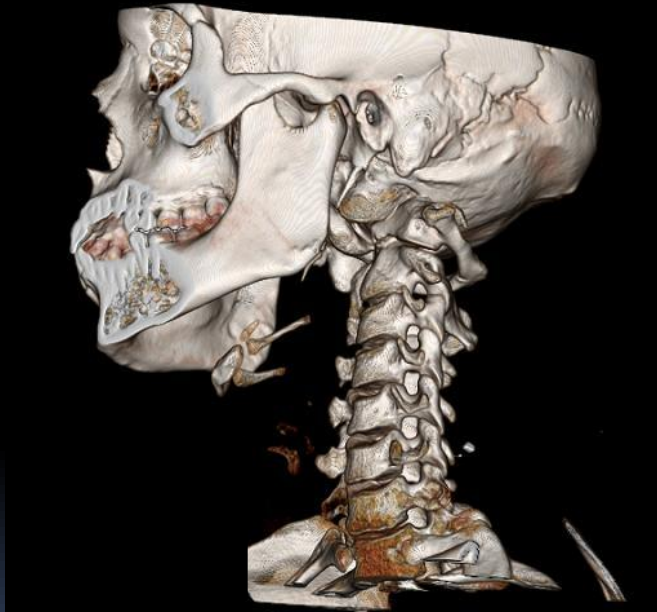


VR 3D oblique view



Virtual dissection view

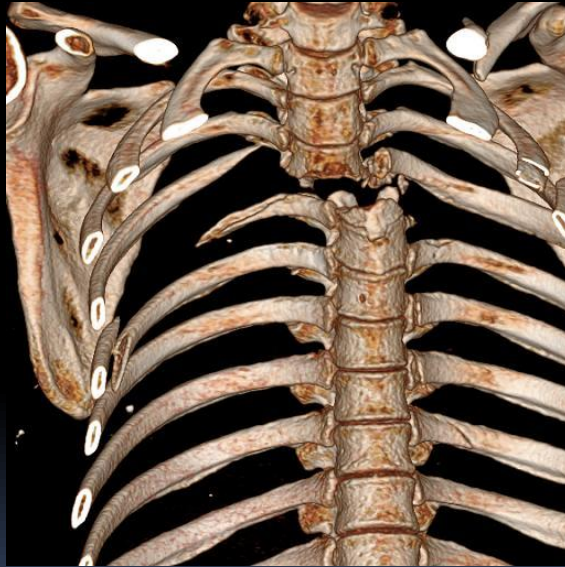
Rotational Atlanto-Occipital Dislocation -



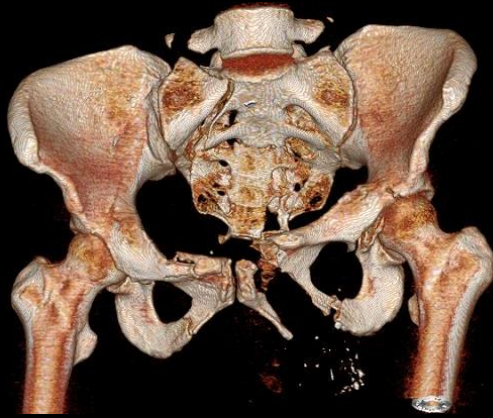
Sagittal midline view shows brain stem severed at autopsy

Case 4: Distraction Fracture-Dislocation of T3 Vertebra

Victim of high speed MVA with multiple severe injuries



Same
case



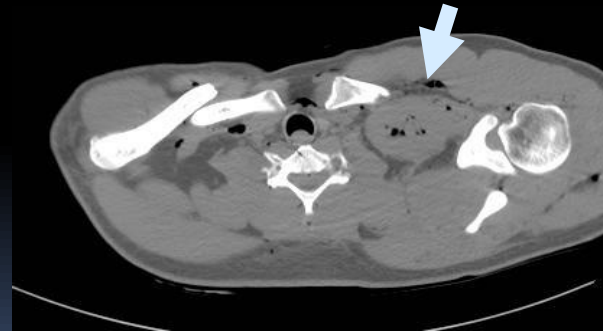
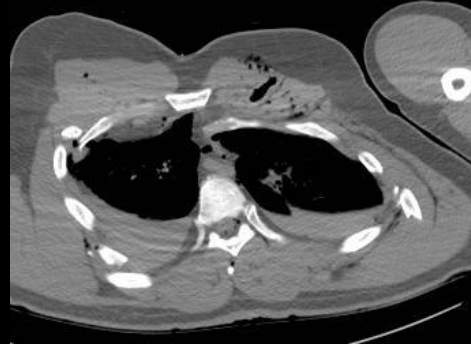
Driver dead at scene

Case 5: Severe Torso Crush Injuries – Dead at scene

Sternal & 1-12 rib fractures bilateral, Open-book bilateral pelvic fract/disloc.

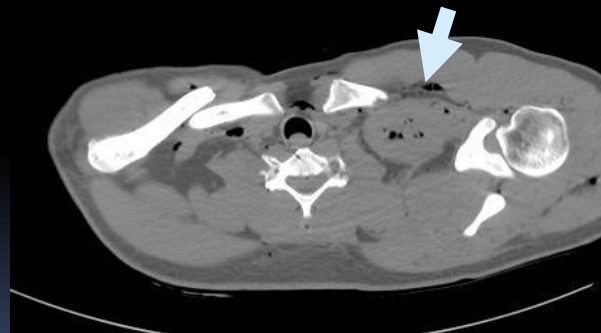
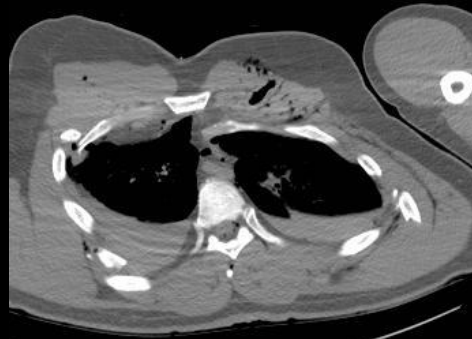
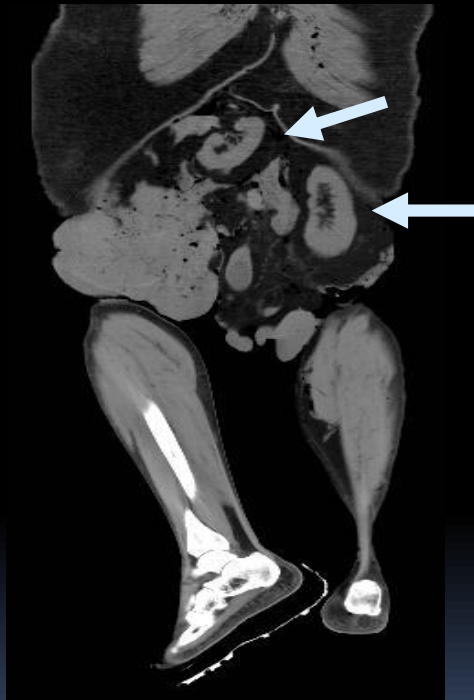


Same Case: Herniation of mediastinal and abdominal organs



Family opposed to autopsy

Same Case: Herniation of mediastinal and abdominal organs



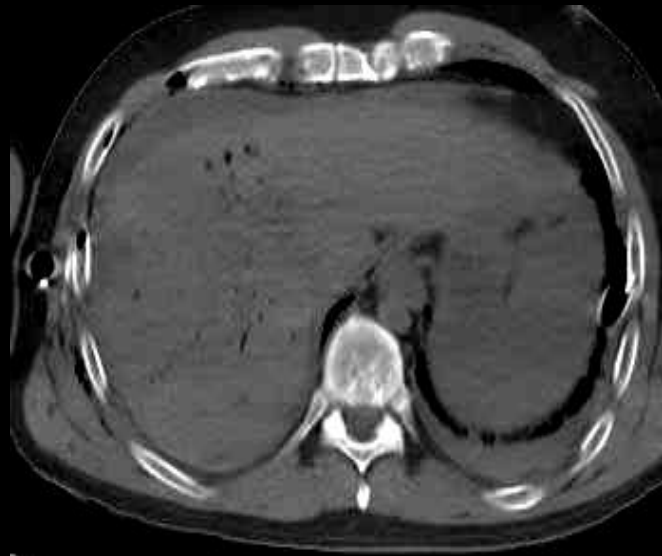
Case 6: Driver in High Speed MVC

CT showed big hemoperitoneum and abnormal liver with distorted gas pattern

* Extent of liver injury and source of bleeding not seen unless PMCT Angiogram performed

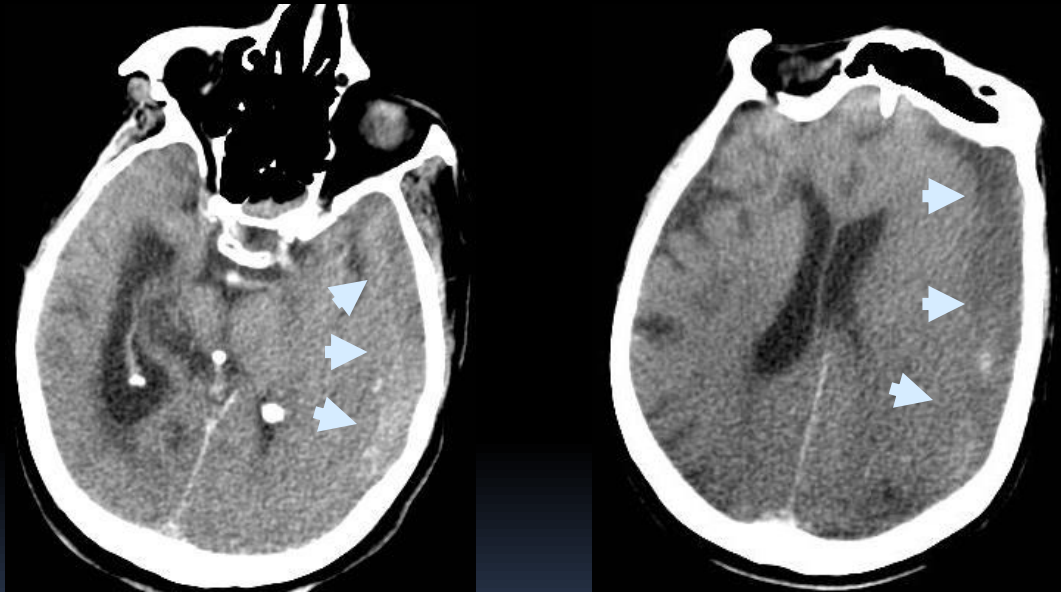


Same case: CT and Autopsy comparison



Case 7: Undetermined Death of Elder following Accident in Nursing Home

Death determined on PMCT as due to subdural hematoma (arrows)



Autopsy not performed due to religious objections

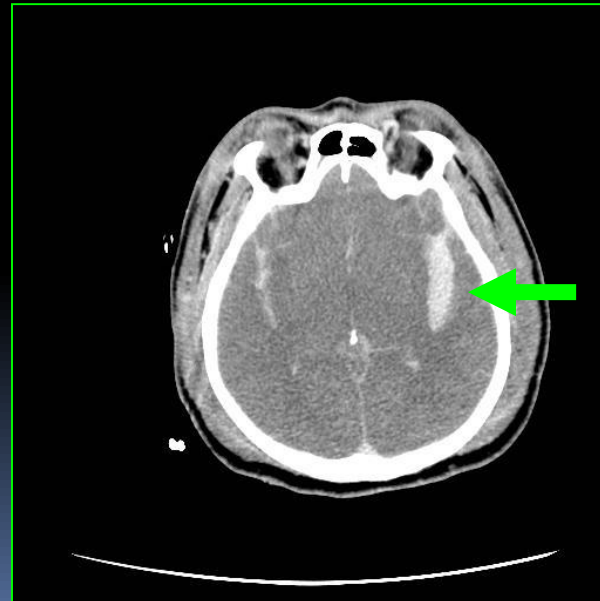
Case 8: Suspected Traumatic Death

Driver in roll-over MVC – CT showed subarachnoid bleeding++ and some scalp contusions – **NO MAJOR INJURIES**

CT diagnosis of likely aneurysm bleed confirmed at autopsy – Likely lost consciousness before accident



Not actual event



Weaknesses of PMCT versus Traditional Autopsy ?

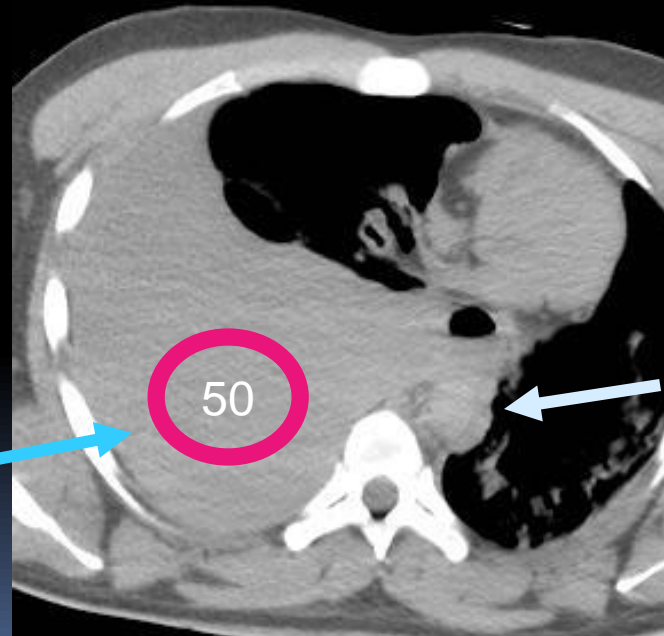
- Common false-negative findings at CT include:
 - Laceration of aorta and other vessels - can see bleeding but not source
 - Non-displaced fractures or dislocations
 - Soft tissue and organ injuries, especially if small or subtle
- Common false-negative findings at Autopsy:
 - Spinal fractures/dislocation
 - Air embolism
 - Pneumothorax

Example of False-negative findings at CT:

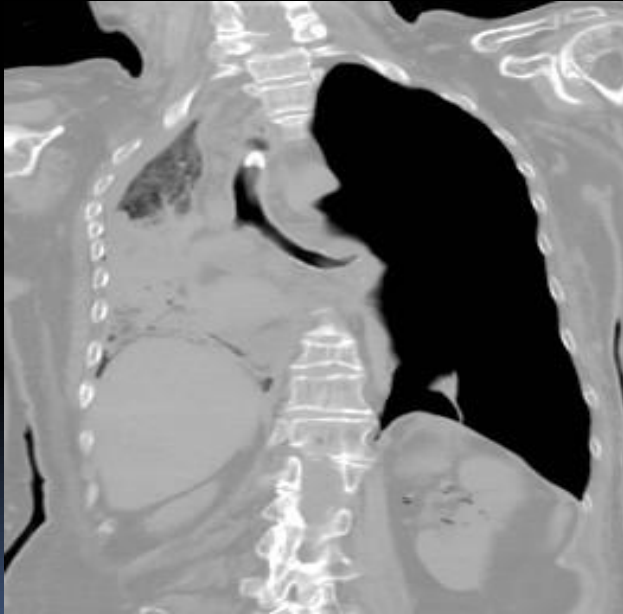
Fatal large Hemothorax from laceration of ascending aorta not seen on CT

Limitation of non-enhanced study (no contrast dye used)

Attenuation (Density) measurement of pleural fluid is ~ 50 Hounsfield units = blood



Example of False-negative findings at Autopsy:
Tension Pneumothorax in Chronic Lung Disease



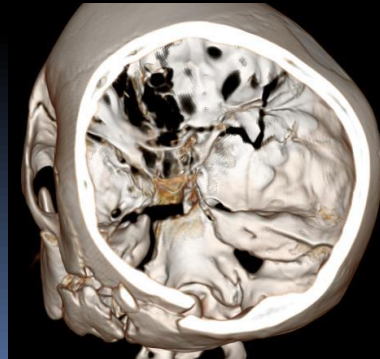
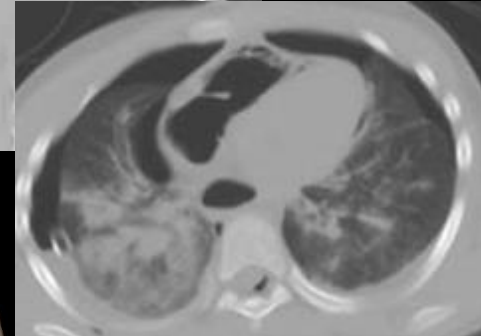
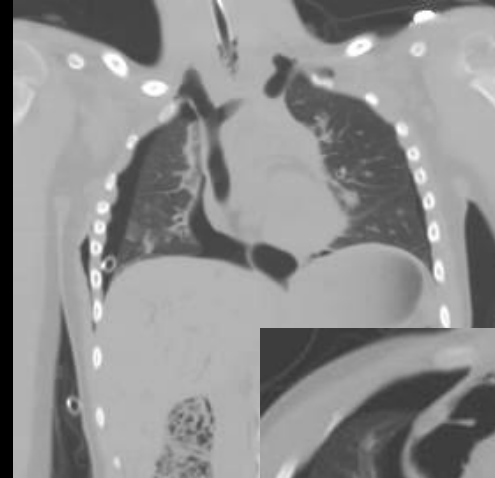
Example of False-negative findings at Autopsy:

Air Embolism

Seen in association with major skull base or thoracic fractures or ballistic/knife injuries to major vessels

Contribution to death not well understood but importance may be underestimated

Need special techniques to identify at autopsy – more easily seen at CT



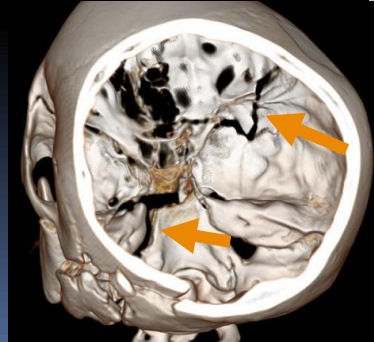
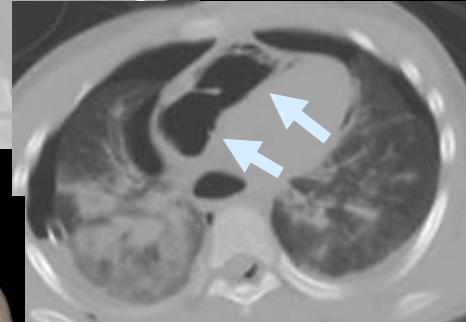
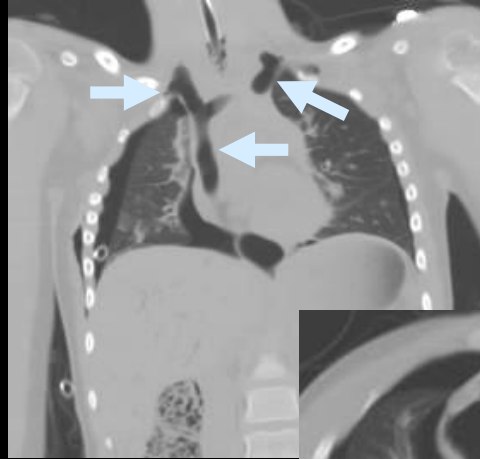
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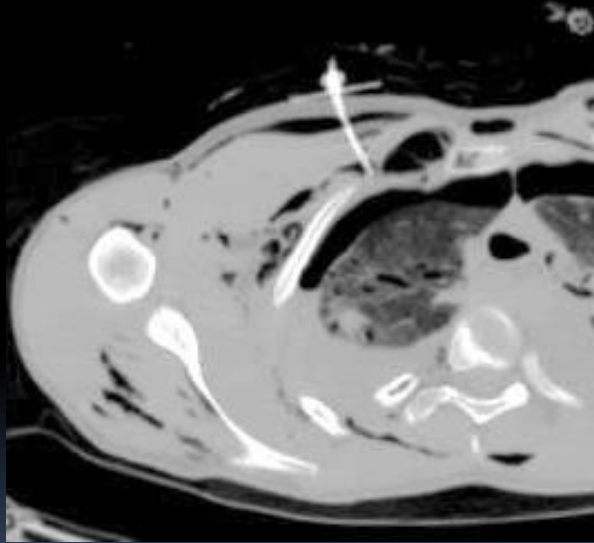


Post-Resuscitation Devices at PMCT

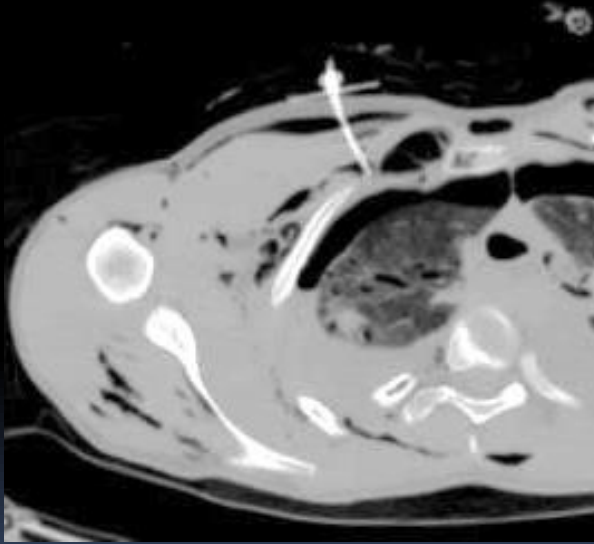
- Usually left in place after unsuccessful attempted resuscitation
- Noted at traditional Autopsy but correct/incorrect position not described – not a QA process
 - Catheters/tubes may have migrated from original location
 - Typically placed emergently
 - Often placed under difficult conditions
 - In the field/at night
 - Children especially challenging
 - Intubation problems
 - Venous access

Bilateral Hemo-Pneumothorax

Attempted chest drainage with venous catheters



Fatal outcome likely related to large amount of bleeding from aortic rupture also



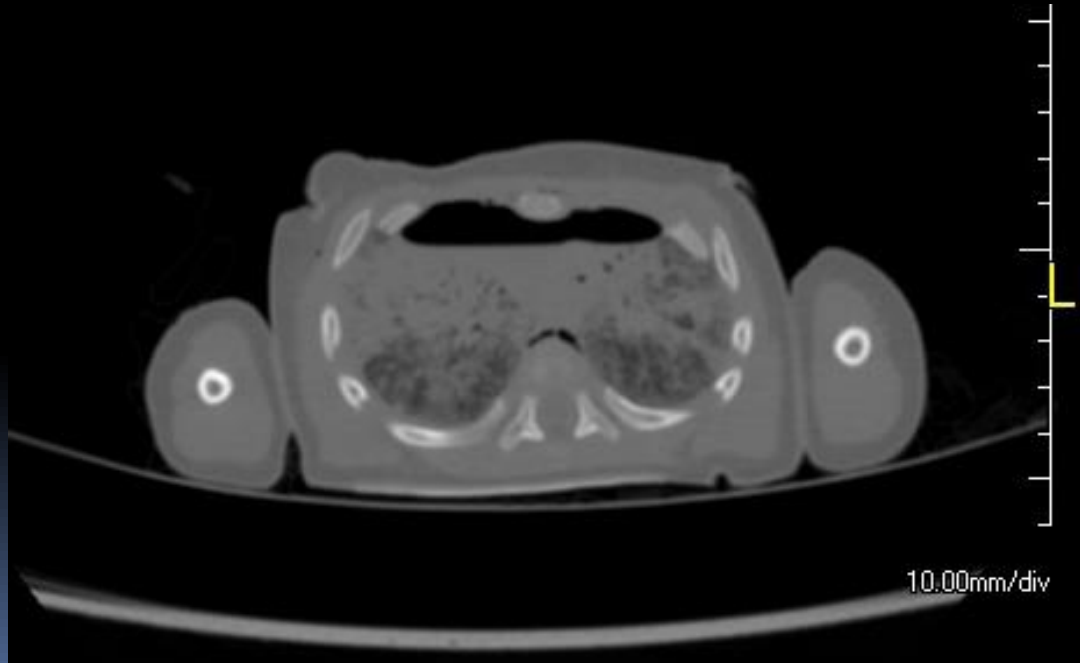
Attempted chest drainage with venous catheters

- Venous catheters used for emergency chest drains need to be longer
- People getting larger !
 - Obesity - at every age
 - Larger muscles in healthy younger males
 - noted in military deaths in Iraq

Not everyone has got this message yet...

Over-aggressive attempted resuscitation of an infant - SUDI case

Bilateral rib fractures, lung contusions and pneumothorax



Conclusions

- Early experience suggests that virtual autopsy using a whole body CT scan shows promise as a sensitive tool for detection of major injuries and cause of death, especially after ***accidental blunt trauma***
- Potential to replace or enable limited, focused autopsy in such cases
- Potential to provide feedback on CPR techniques
- In ***non-accidental traumatic death***, CT can be a valuable adjunct to mandatory autopsy for detection of injuries and ballistics
 - May shorten autopsy time
 - Provides better record of injuries than traditional radiographs – now used in court

Suspected Elder Abuse

Utility of Whole-Body Computed Tomography Imaging in Postmortem Detection
of Elder Abuse and Neglect: Comparison with and Potential Substitution for
Standard Autopsy

U.S. National Institute of Justice

Office of Justice Programs Grant: 2007-DN-BX-0007

<https://www.ncjrs.gov/pdffiles1/nij/grants/237613.pdf>

Introduction

Elder abuse (EA) contributing to death is a crime that is currently considered difficult to exclude without a full conventional autopsy, even where allegations of abuse are questionable or are limited to nonphysical issues

Purpose

We investigated the potential for use of whole-body post mortem CT (PMCT) as a triage tool to determine the need for conventional autopsy based on detection of injuries suggestive of physical abuse and/or evidence suggestive of neglect

METHODS AND MATERIALS

- 58 decedents (14 M, 44 F; mean age 76 years, range 52-93 years) had PMCT and subsequent conventional Autopsy by state medical examiners within 24 hours of death
 - in all cases allegations of EA had been made by family members, caregivers or physicians
- Sensitivity of PMCT for injuries suspicious for abuse, evidence of potential neglect, and other major findings were determined with Autopsy as the standard of reference

METHODS AND MATERIALS

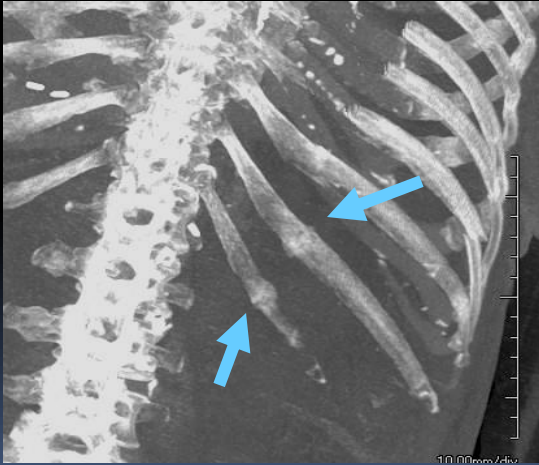
- Injuries considered suspicious for abuse:
 - Unsuspected or unreported injuries, especially in bedridden decedents or in presence of malnutrition and dehydration
 - Fractures
 - of differing ages
 - of long bones and ribs
 - of atypical type (e.g., spiral fracture of the humerus suggesting inflicted injury rather than a fall)
 - Injuries in locations unlikely to be the result of a fall or self inflicted
 - Cranial trauma — scalp, subdural and other intracranial hematomas
 - Evidence for abdominal organ injuries, or intra-abdominal hemorrhage
- Evidence of potential neglect
 - Decubitus sacral or ischial tuberosity ulcers, especially if deep

RESULTS – Elder Abuse

- PMCT and Autopsy were concordant in the exclusion of evidence suspicious for elder abuse in 57/58 cases
- PMCT and Autopsy were concordant in the detection of evidence suspicious for elder abuse in 1/58 cases
 - Both investigations demonstrated multiple previously unreported new and old rib fractures of varying age in this single case

Multiple undocumented new and old rib fractures suspicious for elder abuse

Old Fractures



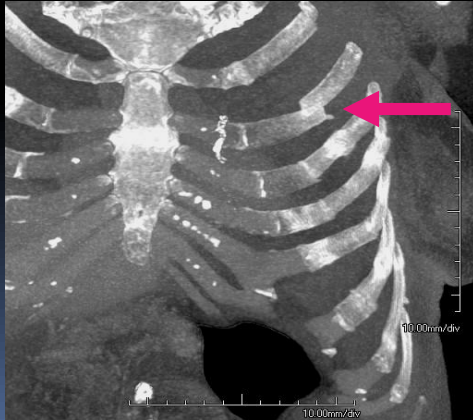
New Fracture

RESULTS - Fractures

- PMCT noted acute bilateral upper rib fractures in 20/21 decedents who had attempted cardiac resuscitation (CPR)
 - These injuries were undetected at Autopsy in almost half of such cases (11/21)
- PMCT noted other fractures typical for accidental trauma in 5/58 cases
 - These injuries were undetected at Autopsy in 4/5 cases
- Post mortem PMCT failed to detect 2 fractures identified on autopsy

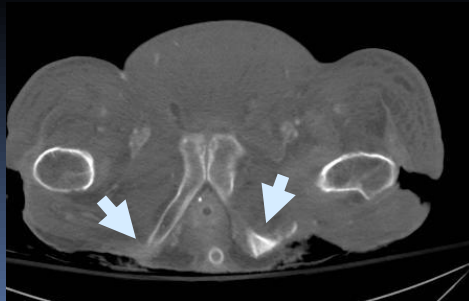
RESULTS: Rib Fractures

- Multiple acute rib fractures seen in 20/21 cases on PMCT
 - Multiple bilateral, upper, anterior locations in all cases
 - All cases associated with attempted Cardio Pulmonary Resuscitation
 - Likely related to brittle, osteopenic bone



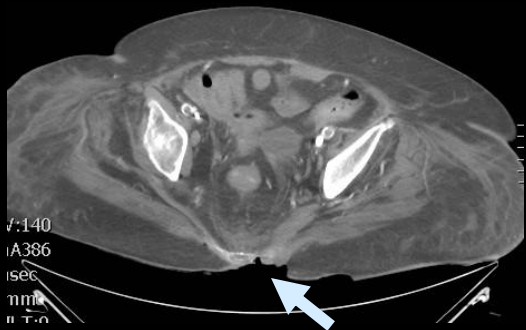
RESULTS: Decubitus Ulcers

- PMCT identified decubitus ulcers in only 8/17 cases noted at Autopsy
 - Missed *superficial grade 1-2* decubitus ulcers in 9 cases
- PMCT identified *deep grade 4* decubitus ulcers /deep abscesses/septic discitis in 3 cases missed at Autopsy

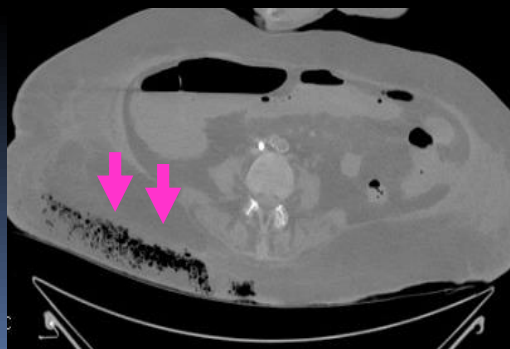


Stage 4 deep ischial
ulcers involving bone
not detected on autopsy

Discordant Findings between PMCT and Autopsy



Deep decubitus ulcer
of sacrum



Large subcutaneous
abscess at L3 level

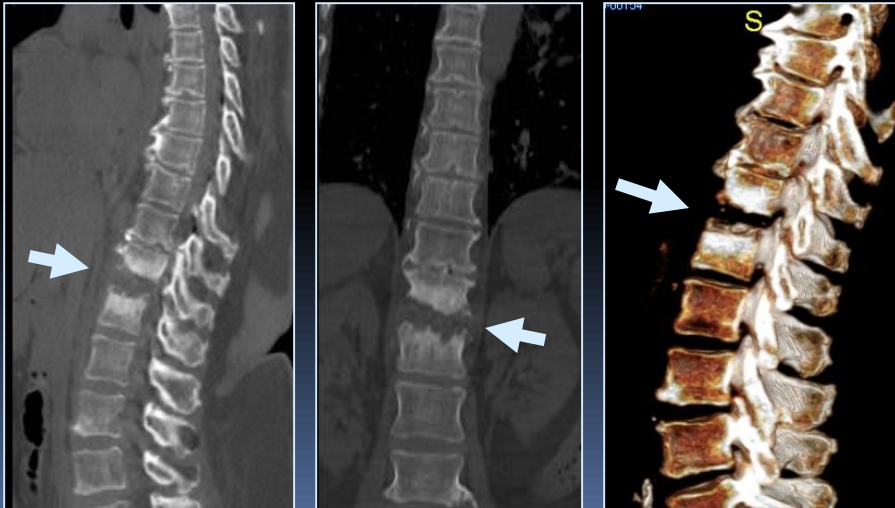
Cause of Death:
Septicemia of unknown
cause

No evidence for
Abuse

Subcutaneous
abscess not detected
on autopsy

Discordant Findings between PMCT and Autopsy

Unsuspected Infectious Discitis of T12-L1



Cause of Death:

Septicemia of unknown cause

No evidence for Abuse

Infectious discitis not detected on autopsy

RESULTS

Cause of Death:

- Determined by PMCT in 24/58 (41%) cases
- Determined by Autopsy in 58/58 (100%) cases

» Major Causes of death determined as

➤ Cardiovascular	29
➤ Chest infection	8
➤ Accidental Head Injury/Neurologic	5
➤ Septicemia	4
➤ Pulmonary embolism	3
➤ Accidental medication overdose	2
➤ Other	6
➤ suspected elder abuse case	1

(Ketoacidosis + multiple co-morbidities)

Discussion

Cause of Death:

- As expected, PMCT was not reliable for detection of cardiovascular and many other natural causes of death
 - Important to emphasize limitations of PMCT in this respect
- Conventional Autopsy included Toxicology, External Examination, Death Scene investigation and Medical Record review and determined the cause of death in all cases

Discussion

STUDY LIMITATIONS

- This study is limited by the low number of positive cases – only a single positive case was identified in this series of 58 decedents
- The low % of positive cases may reflect limited awareness for elder abuse among family members, caregivers, and the healthcare system in general, and subsequent failure to refer suspicious cases
- Alternatively, this study may support a view that many cases are referred to the medical examiner with allegations of abuse that are related to non-physical issues, medication problems or general unhappiness with care facilities among next-of-kin

Conclusions

- PMCT appears reliable for the detection or exclusion of skeletal injuries suspicious for elder abuse and may be used (in correlation with history and external examination) to determine the need for Autopsy where allegations or suspicion of abuse are raised
 - *Further research in a larger cohort including more positive cases would be helpful to confirm*
- Deep decubitus ulcers suggestive of neglect are more accurately detected and characterized at PMCT than at Autopsy
 - Superficial ulcers are better seen on external examination

Conclusions

- In this group PMCT was not reliable for determination of cause of death
- 32 of 58 cases had a diagnosis of cardiovascular death

Clinical Relevance

- PMCT may be used as a triage tool to help the medical examiner determine the need for conventional autopsy when allegations of elder abuse are made
- Acute upper anterior bilateral rib fractures were noted in all decedents who underwent full CPR, and are likely related to osteoporosis
 - *This information is of value for Emergency Room staff and may influence both CPR techniques and decisions to perform CPR in the elderly*

Thank you for your attention !

