NOTE: IMAGES OF IDENTIFIED CASE REMAINS HAVE BEEN REMOVED. DESCRIPTIONS ARE PROVIDED FOR HANDOUT.

Terminology

- **Trauma**: while person is living or at the time of death
  - ANTEMORTEM (1-2 weeks before healing is visible; periosteal reactivity after few days in children (under magnification) (Barbieri & Sledzik, 2008)
  - PERIMORTEM – At or about the time of death. Operationally: lacks signs of healing; bone breaks are influenced by more elasticity, not brittle.

- **Taphonomic modifications** occur after death (can be human agency)
  - POSTMORTEM

Taphonomic modifications

- Dismemberment
- Scavenger modifications
- Fire
- Water transport
- Geological forces (e.g., erosion)
- Weathering
- Recovery, autopsy
- Most taphonomic changes are continuous
Anthropologists & pathologists use “perimortem” differently

- Forensic pathology – more precise
  - Detection of hemorrhage (heart still beating)
  - “Perimortem” at or about the moment of death
- Anthropology – application NOT PRECISE
  - Detecting indicators of moisture & fat loss
    - “Perimortem” when bone still moist & elastic enough to “act” fresh biomechanically

Bone trauma only rarely has evidence of hemorrhage

(Image of newborn skeletal case with traumatic defect)
Ectocranial View – CLOSE-UP IMAGE OF INFANT PARIETAL

Endocranial view – CLOSE-UP IMAGE OF INFANT PARIETAL
In the absence of signs of hemorrhage... Was the bone fresh (wet) when the modification happened?

Indicators of Taphonomic versus Traumatic Status

- Loss of Bone Flexibility and Elasticity
- Fracture pattern
- Staining
- Desiccation
- Plastic deformation
- Ruling out taphonomic signatures
- Place within a sequence of change

Perimortem to postmortem transition = a continuum

- Looking “fresh” or “wet” (i.e., “perimortem”)
  - Can last a long time; depends on context
  - Related to amount of elasticity remaining, affecting the biomechanics of fracture
  - Presence of cartilage, moisture & fat
  - Elasticity can be lost even if bone stays “wet”
- Intermediate state between perimortem wetness & postmortem dryness is the problem
Futile search for universals of postmortem timing in forensics…

Such as…
- How long does it take for a body to decompose?
- How long does it take for a bone to stop acting fresh?

Condition depends on context

- Bone retains material properties of being fresh for weeks to months
  - Elastic due to presence of cartilage, moisture & fat ("viscoelastic property")
  - Gradual loss of moisture and fat in most situations
  - Mostly depends on environment (wet vs. dry)

Type of bone matters

- Long bone versus flat bone
- Cortical bone tissue retains elasticity longer than spongy bone
Fracture Pattern in Long Bones

Usually perimortem
- “Spiral” fractures with relatively smooth fracture margins
- “Butterfly” fractures

Usually postmortem (Lack of radial pattern with impact)
- Transverse or step fractures with rougher fracture margins

Adapted from Wedel & Galloway, 2014, Figure 5-2, p. 64

Perimortem type spiral fx

But postmortem type step/transverse fx
So probably not perimortem
Staining

- Fracture margin versus adjacent surface
- Fracture margin (cortical bone) exhibits less stain
- Clearer on long bones

Staining on perimortem fracture margin on left versus lack of staining on postmortem fracture margin on right. TAPHONOMIC BACKGROUND: Decedent jumped from high bridge into a large, fast-moving river in northern New England, and was transported to and partially buried in a sand bar. Skeletonized body was found in anatomical position 8 years later. Postmortem fracture occurred at time of discovery.

More recent (postmortem) fx is unstained
Smooth vs. rough fx margins

Anterior view of postmortem sharp force defect on inferior pubic ramus (arrow). With magnification, defect cut walls were found to be unstained, and cortex was stained. BACKGROUND: Decedent missing for ten years was found in northern New England wooded site. Skeletal elements were scattered.
Staining
Re-associated fragments of left innominate, fractured in the perimortem period.

TAPHONOMIC BACKGROUND:
Decedent was hitchhiking on northern New England highway, and was hit with motor vehicle. Scattered remains were found 5 years later in slightly wooded area 30 feet from highway and down a steep slope adjacent to road shoulder.

Plastic deformation
Plastic deformation is a characteristic of fresh bone that becomes warped due to “slow loading” impact
- Bending as a result of blunt force, beyond the point where it can bounce back to its original shape.
- Gunshot projectiles are too rapid for bone to warp

Plastic Deformation
Close-up of the anterior portion of the fracture showing differential fragment staining and plastic deformation (fragments are slightly warped and do not fit perfectly).

Image of innominate reconstructed from two fragments
Close-up showing stained fracture margin

Close-up image showing plastic deformation in pelvis
Desiccation

- An indication of postmortem status
- Can create defects
- Can modify perimortem defects

Desiccation cracks

Comparing desiccation cracks (left) with sharp force trauma (right). Taphonomic background: Scattered skeletal remains (Left) were found in NNE woods; decedent missing 3 years. Partly decomposed & skeletonized remains (Right) found partially submerged in a stream in May after individual had been missing for 1 year.

Depressed Fracture

- Depressed fracture with heaving concentric fractures is a pattern characteristic of the perimortem period. Experimental study of hammer blows to 5 fleshed & 5 nonfleshed pig skulls over 12 month postmortem period. Taphonomic change can mimic perimortem fractures (Oalc & Rogers 2007)
Depressed Fracture
Perimortem depressed fracture in frontal bone. Note the bone surrounding the sharp force lesion, including concentric, heaving fractures.

TAPHONOMIC BACKGROUND:
This is an historic specimen of unknown provenance.

Cannot R/O Postmortem

Rule out taphonomic signatures
- Known patterns
  - Scavengers
    - Carnivore modification – often perimortem, associated with defleshing
    - Rodent modification – often late postmortem
  - Dismemberment
  - Recovery & excavation damage
  - “Trophy” skulls
  - Autopsy
R/O Carnivores

- Can you rule out carnivore involvement?
  - Are there carnivore patterns?
    - Evisceration
    - Extremity units missing
    - Long bone end modification
    - Spiral fractures (since it is usually in the perimortem period)

Rule out scavenger bone modification pattern

- Can mimic blunt force trauma
- Can occur in antemortem, perimortem or postmortem period
- Whole pattern recognition
  - What is there and what is missing
  - Extent & type of scatter
  - Morphology of all modifications in the bone

Canids: (domestic dogs, coyotes, wolves, foxes) can mimic blunt force trauma

- Depending on the size differential between the canid and the bone being modified & bite force...
  - Impact scar or depressed fracture
  - Spiral fracture in long bone
  - Comminuted fracture
Bear, not coyote, in this case

Canid pattern

- Punctures
- Pits
- Grooves
- Chipping long bone back from end into marrow cavity
- Smaller bone may have pits, punctures, & impacts on opposite sides
R/L proximal tibiae: Chipping back to marrow

Pelvis: canid modification

Canid typical sequence

- Haglund canid modification sequence (Haglund, 1989)
  - Stage 0: No bony involvement Defleshing, head
  - Stage 1: Ventral thorax damaged and one or both upper extremities removed
  - Stage 2: Lower extremity involvement
  - Stage 3: Only vertebral segments remain articulated
  - Stage 4: Total disarticulation
8 IMAGES OF SKELETAL REMAINS EXPOSED IN WOODLAND STREAM & MODIFIED BY CARNIVORES

2 IMAGES OF SKELETAL REMAINS EXPOSED IN WOODS & MODIFIED BY CARNIVORES

Carnivore v. Blunt Force Trauma

- Carnivores can produce blunt force damage
  - Impact scar + radiating fractures
  - Spiral fractures
  - Plastic deformation and warping
- Ask....
  - Is the defect demonstrably perimortem?
  - Was there carnivore access to body?
  - Is this defect part of an overall known carnivore pattern or is it isolated/focal?
  - What are the mechanical limits of the suspected carnivore jaw in terms of size and mobility?
  - Is there another likely competing hypothesis for blunt force? (e.g., fluvial)

Carnivores v. Sharp Force Trauma

- Really not an issue if you use the microscope
  - SFT: grooves bottoms are V-shaped; U-shaped with tooth or claw
  - Look for SFT weapon class indicators: machined grooves on kerf walls
  - Carnivores can’t do hacking
  - Look for other evidence – e.g., in the clothing
Dismemberment

- Pattern of extremity removal or butchery
- Tool marks

5 IMAGES OF DISMEMBERED REMAINS

Rodent pattern

- Usually not confused with perimortem trauma because they like dry bone
- Haglund, 1997
  - Short, parallel scrapes
  - "Windows" scraping and penetrating, then perforating flat bone
  - Removal of processes, parts that protrude from rest of bone, like brow ridges (provides a "purchase" to steady bone with mandible, while maxillary incisors scrape)
Two images of rodent-modified crania

Rodent modification & staining

Probable perimortem crushing blunt force trauma. The main defect border has been modified by rodents, as evidenced by the incisor scraping marks. The fragments from the lateral cranium were scattered in the perimortem period and underwent different exposure to sunlight. TAPHONOMIC BACKGROUND: Decedent was found in the northern New England woods approximately ten years after she went missing.
Thermal damage

- Thermal damage vs trauma
- GSW signature with thermal damage
- SFT signature with thermal damage

Bohnert et al., 1997. Retrospective study of 20 cases placed in cremation under observation, and prospective study of 13 fire deaths. No basal skull fx’s observed.

Sharp force trauma and thermal damage

Posterior right oblique view of C1-C6. Transverse processes of C3 and C4 removed with a sharp instrument. Fire damage to C2 & C3 transverse processes, but not cut edge on C3 & C4. Transverse processes of C5 & C6 may have been cut, burned by the fire, or both.

TAPHONOMIC BACKGROUND: Decedent was known to have been assaulted with a knife, killed and partially burned.

GSW vs. suture vs. thermal damage

Reconstruction of burned and fragmented cranium reveals GSW. Close up of ectocranial surface on bottom left, endocranial surface on bottom right. TAPHONOMIC BACKGROUND: Body recovered in highly burned and fragmented state. Fragments were reconstructed enabling identification of trauma.

IMAGE OF BURNED AND RECONSTRUCTED CRANIUM WITH GSW

CLOSE-UPS OF ENDOCRANIAL & ECTOCRANIAL SURFACES

IMAGE OF CERVICAL SPINE WITH THERMAL DAMAGE AND SHARP FORCE DAMAGE

Colby 2019

Colby 2019

Colby 2019
Macroscopic criteria

**PERIMORTEM LESIONS**
- Bone more elastic
- Outline - radial/spiral-encircling diaphysis, breakaway spur/notch; impact scar (loading point) present
- Long bone fx angle sharp, obtuse or acute
- Texture fx margins smooth
- Color fx margin same as surface
- Fracture more complex
- Fracture doesn't cross epiphyseal ends

**POSTMORTEM LESIONS**
- Bone is brittle, rigid
- Outline - perpendicular to horizontal fracture surface; loading point absent
- Long bone fx angle - right angles to axis
- Texture fx margins rough
- Color-fx margin lighter than surface, unstained
- Fracture simpler
- Fracture may crosscut epiphyseal ends

Biases in the literature

- Emphasis on cortical bone tissue morphology (instead of spongy bone)
- Emphasis on long bones (instead of flat bones)

Testing of macroscopic methods of peri/postmortem assessment

- Cappella, Amadasi et al. 2014
  - 210 fractures with known history in 4 victims, 2 anthropologists
  - Approx. 15% error rate (10%-22%), most for trabecular bone.
Testing of macroscopic methods of peri/postmortem assessment

- Cappella, Castoldi et al. 2014
  - Seven autopsied cases with known fracture history (peri-mortem fx, post-mortem excavation fx @ 20 years)
    - GSW & SFT evidence persist
    - BFT more problematic
- E.J. Pope, E.O. Smith, 2004
  - Tested 40 cadaver heads. SFT and GSW persisted.
- Hermann and Bennett, 1999
  - Tested pig skulls to see which perimortem lesions persisted and could be differentiated from heat fractures.
    1. SFT persisted the best

Problematic situations

- Thin cortex
- Flat bones
- Spongy bone
- Small, fragile bones (e.g., hyoid: recovery, rescuscitation, strangulation/hanging?)
- Taphonomic effects with very long PMI
- Failure to document modifications that occur during recovery or examination

Other Postmortem Artifacts

- Bird (cf. carnivore flesh removal, transport)
- Insect modifications (soft tissue)
- Root etchings (not V-shaped)
- Fluvial & current transport (mimics SFT and/or BFT)
- Sea snails remove long bone end thin cortex and spongy bone (mimics rodents)
- The forensic backhoe operator can produce BFT
- Trophy skulls
SUMMARY: Stripping Away The Taphonomic Overprint

- Differentiate trauma from:
  - Antemortem pathology
  - Perimortem artifact (e.g., scavenger, fluvial)
  - Postmortem damage/modification

- When examining bone, must define "perimortem" in taphonomic terms:
  - Period when bone behaves as though it is fresh

Taphonomic approach needed to differentiate traumatic & postmortem modifications:

- Context is important:
  - Documenting access to moisture, heat, scavengers at the scene

- Complete inventory is important:
  - Thorough search & recovery—ability to identify taphonomic patterns and signatures

- Thorough documentation of condition is important:
  - Patterns for each element & region

References (1)

References (2)


References (3)