

Trauma Analysis

1.0 Principle, Spirit and Intent

Skeletal remains should be analyzed in a systematic manner for the purpose of determining both timing and mechanism of skeletal (*i.e.* osseous and dental) trauma that may be relevant to the circumstances of death or other pertinent forensic questions. Analysis of trauma should involve careful observation and thorough documentation, and interpretations should be based on scientifically valid methods and principles.

2.0 Purpose and Scope

The following guidelines outline procedures for describing, documenting and interpreting skeletal trauma. These guidelines apply to all practitioners of forensic anthropology and should be implemented to the fullest extent practical and appropriate. In the absence of specific procedures or in the case of conflicting procedures, the principle, spirit and intent should be met.

3.0 General Principles

Forensic anthropologists may contribute to trauma analysis through assessment of: (1) the timing of the trauma (*i.e.*, antemortem, postmortem or perimortem), and (2) the mechanism that produced the trauma (*i.e.*, projectile, blunt, sharp, thermal).

The analysis of trauma requires the application of elements of physics, biomechanics, materials engineering, ballistics, taphonomy, anatomy and osteology. Even still, a definitive conclusion may not be forthcoming and equivocal results should be reported as such.

With the exception of cartilage, which may be examined for trauma by the anthropologist, soft tissue examination is typically the purview of the pathologist.

Documentation should include descriptive text, photographs, diagrams and radiographs. Descriptions should include the location and characteristics of trauma using measurements and standard anatomical terms.

When assessing skeletal trauma, remains should be examined before and after processing, and clothing damage relative to skeletal alterations should be considered when possible.

Careful consideration should be given when estimating the post-injury interval.

A distinction must be drawn between description and interpretation. A description is essential to any report of trauma, but it is important to reserve an interpretation for cases where observations supporting a specific conclusion can be enumerated.

4.0 Best Practices

4.1 Trauma Timing

Characteristics and morphology of the alteration are used to assess when the trauma occurred relative to the death of the individual. Trauma timing may be classified as antemortem or perimortem. Postmortem alterations to bone are considered taphonomic events rather than trauma but will be addressed in these guidelines.

To classify trauma timing, the alteration should be examined visually. Examination may also include the use of a low magnification microscope and/or radiography. When a distinction cannot be made between antemortem, postmortem and perimortem, this should be clearly stated.

4.1.1 Antemortem Trauma

Antemortem trauma refers to an alteration produced before an individual's death that displays evidence of osteogenic reaction. Features that may indicate antemortem trauma include:

- Evidence of healing or healed fractures
- Development of a pseudarthrosis
- Trauma-induced degenerative joint disease
- Infectious response
- Dental fractures with worn edges
- Surgically implanted devices

When trauma is classified as antemortem, consideration should be given to:

- Fracture type (e.g., simple, spiral) and the degree of healing to the fractured edges/margins
- The age of (time since) the trauma, which may affect the ability to identify the mechanism of trauma
- Biological factors such as age, sex, pathology and nutrition, which may affect healing rate
- Whether the trauma may present evidence for identification and cause and/or manner of death
- Whether re-injury may have occurred, interrupting the healing process

4.1.2 Perimortem Trauma

Perimortem trauma refers to an injury occurring at or around the time of death. Because of the properties of bone, the timing of injury is less precise when evaluating bone than when evaluating soft tissue. Within the anthropological realm, perimortem is determined on the basis of evidence of the biomechanical fracture characteristics of fresh bone. Perimortem trauma is a category in which remains lack evidence of healing and lack diagnostic taphonomic evidence of postmortem damage. Features that may indicate perimortem trauma include:

- A lack of osteological activity such as healing or infectious response
- The presence of fresh bone fracture characteristics (e.g., plastic response)
- The absence of dry bone fracture characteristics (e.g., angular fractures)
- An overall fracture pattern characteristic of a terminal event (e.g., rapid deceleration event)

When trauma is classified as perimortem, consideration should be given to:

- Cautious use of the term perimortem, since it is used with varied temporal precisions within the forensic community; thus, an explanation of the term should be provided with clear reasons for a perimortem classification
- The inability to distinguish between antemortem, perimortem and postmortem damage should be clearly stated
- Classification of trauma as perimortem is strengthened when the mechanism can be identified
- Other indicators that may establish trauma as perimortem (e.g., hair entrapped in bone with associated blunt trauma injuries, the presence of blood staining)

4.1.3 Postmortem Damage

Postmortem damage refers to taphonomic alteration or defects produced after an individual's death that are unassociated with the death event. Features that may indicate postmortem damage include:

- Differentially stained or recently exposed surfaces
- A lack of healing
- Characteristics of the break lacking evidence of a plastic component.
- Pattern of damage

When alterations are classified as postmortem damage, consideration should be given to:

- Terminology used to describe the alteration - terms such as “damage” or “breakage” are preferred when describing postmortem incidents; the term “fracture” should be reserved for viable bone
- Possible confusion with perimortem trauma

4.2 Trauma Mechanism

Trauma mechanism refers to the force(s) that produce skeletal alterations and may be classified as resulting from high-velocity projectile, sharp force, blunt force or thermal exposure. Assessment of trauma mechanism is dependent on pattern recognition as well as the contributions of intrinsic and extrinsic factors that dictate the way bone fractures.

To classify trauma mechanism, the alteration should be examined visually and, when possible, before processing occurs. Examination may also include the use of a low magnification microscope and/or radiography. Reconstruction of fractured bones should be done to clearly establish the trauma mechanism unless circumstances do not permit reconstruction. Fracture margins and the angle of fracture surfaces can be important in interpretation and should be examined before reconstruction. Observed patterns should be compared to literature or other reference material to aid in classification of mechanism. Sequence multiple wounds only when there are clear indications of the order. When temporal wound sequencing cannot be done by the analyst, this should be clearly stated.

4.2.1 High-Velocity Projectile Trauma

High-velocity projectile trauma is produced by impact from a projectile (typically gunshot or explosive-related) traveling at a high rate of speed. Features indicating high-velocity projectile trauma include:

- The presence of a projectile in association with the bone
- Projectile entrance and/or exit wound characteristics
- The presence of residue, wipe or remnants of the projectile
- Fracture pattern indicating a high velocity impact
- Beveling of concentric fractures in bones of the cranial vault that indicate an internal to external force

When alterations are classified as high-velocity projectile trauma, consideration should be given to:

- Identification of entrance and exit wounds providing description (indicating details of bevel), measurements, anatomic location and projectile direction relative to anatomy
- Examination of the endocranial surface for an impact site in the absence of an exit defect
- The presence of gunshot residue (e.g., soot and other materials discharged from a gun) that may represent close proximity of muzzle to target
- Using the term “bullet wipe” instead of “lead wipe,” since the outer surface of a bullet may be composed of materials other than lead
- The possibility of plastic deformation occurring when the projectile is slowed before impact by an intermediate target or energy loss during flight

4.2.2 Blunt Force Trauma

Blunt force trauma is produced by low-velocity impact from a blunt object (e.g., being struck by an object or concussive wave) or the low-velocity impact of a body with a blunt surface (e.g., motor vehicle accident or fall). Features indicating blunt force trauma include:

- Plastic deformation
- Delamination
- Fracture pattern indicating a low-velocity impact
- Location and characteristics of known clinical fractures (e.g., parry, Colles, tea cup, or overall patterns seen in auto collisions or falls from great heights)
- Fractures in contiguous or anatomically related bone
- Tool marks or tool impressions indicating an impact site
- Beveling of concentric fractures in the cranial vault that indicate an external to internal force

When alterations are classified as blunt force trauma, consideration should be given to:

- The possible presence of other substances or materials at or within the alteration
- Possible latent impact sites on the cranium in the form of dark stains resulting from entrapped blood and fat within crushed diploë
- The distribution pattern of the fractures; a single impact can result in fractures of several bones (e.g., a fall resulting in serial rib fractures, shaking an infant resulting in rib and long bone fractures).
- Possible sharp force component
- Hyoid bone fractures since they may result from postmortem insult or an unfused horn that may mimic trauma

4.2.3 Sharp Force Trauma

Sharp force trauma is produced by a tool that is edged, pointed or beveled. Features indicating sharp force trauma include:

- Straight-line incised alterations
- Punctures or gouges
- Chop or hack marks (clefts)
- Kerfs

When alterations are classified as sharp force trauma, consideration should be given to:

- Casting the alteration, where appropriate
- The possible presence of other substances or materials present at or within the alteration

- Pseudo-sharp trauma, such as scrape, score and scratch marks, which are not strictly classified as sharp force trauma
- Possible blunt force component
- Proper terminology to describe alteration and blade dimensions: The alteration is described in terms of length, width and depth while blades are described in terms of width, thickness and length

4.2.4 Thermal Trauma

Thermal trauma is produced by exposure to high temperature or direct contact with flame. Features indicating thermal trauma include:

- Color changes (e.g., yellow, black, white)
- Delamination
- Burn pattern
- Shrinkage
- Charring or calcination
- Fractures

When alterations are classified as thermal trauma, consideration should be given to:

- Assessing whether a bone was fresh or dry when exposed to heat
- Identification and interpretation of aberrant patterns of burning that may provide information about the death (e.g., lack of pugilistic posture)
- Differentiation of thermal fractures from fractures associated with other types of trauma

5.0 Unacceptable Practices

The following practices are considered unacceptable and should be avoided when analyzing skeletal trauma:

- The use of terms considered inflammatory or indicating a particular outcome such as “victim” (vs. “decedent”), “weapon” (vs. “tool or “object”), “violent”, “fatal,” “suffer” (as in “suffered an injury”) and “lethal”
- Speculation as to the ultimate cause of antemortem trauma except in cases that show identifiable patterning or radiographic evidence of identifiable foreign bodies
- Over-reaching, narrowly restricted, and/or unsupported results. When uncertain, simply describe alterations
- Use of the term “ballistics” to refer to “gunshot wound.” The term “ballistics” refers to the study of bullet behavior within a firearm (internal ballistics), in flight (external ballistics), or within the target (terminal ballistics)
- Identification of bullet caliber from measurement of the entrance wound defect
- Estimation of muzzle distance to target

- Estimation of temperature or duration of heat exposure
- Use of the term “hesitation mark” to describe superficial cuts or saw marks in bone
- Determination of the maximum number of impacts (be it blunt force, sharp force or high-velocity projectile).
- Individualization of a tool; instead, simply describe the characteristics of the affected surface
- Analysis of material observed within a defect, which may be beyond the practitioner’s expertise.