ASB Standard 147, First Edition
2023

Standard for Analyzing Skeletal Trauma in Forensic Anthropology

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Standard for Analyzing Skeletal Trauma in Forensic Anthropology

ASB Approved Xxxxx 2023

ANSI Approved Xxxxxx 2023

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Foreword

This standard was developed to provide guidance to practitioners for recognizing, describing, interpreting, and reporting trauma in skeletal material. Trauma analysis is a component of anthropologic examination needed to identify traumatic events occurring before and during death and differentiate from damage occurring after death. This document is intended to assist forensic anthropologists when assessing trauma from skeletal elements.

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This document was revised, prepared, and finalized as a standard by the Anthropology Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Anthropology Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

Questions, comments, and suggestions for the improvement of this document can be sent to AAFS-ASB Secretariat, asb@aafs.org or 401 N 21st Street, Colorado Springs, CO 80904.

All hyperlinks and web addresses shown in this document are current as of the publication date of this standard.

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Keywords: *trauma analysis; skeletal examination; trauma timing; trauma mechanism*

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Standard for Analyzing Skeletal Trauma in Forensic Anthropology

1 Scope

This standard provides requirements for documenting, describing, interpreting, and reporting skeletal trauma in forensic anthropology. It also provides requirements for the determination of trauma timing (i.e., antemortem, perimortem, or postmortem) and the identification of the mechanism that produced the trauma (i.e., projectile, sharp, blunt, or thermal trauma). This document does not address cause and manner of death.

2 Normative References

There are no normative reference documents.

3 Terms and Definitions

For purposes of this document, the following definitions apply.

3.1
antemortem trauma
A skeletal defect that occurred before an individual's death and shows evidence of osteological reaction.

3.2
blunt trauma
A skeletal defect 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).

3.3
delamination
A separation of cortical and cancellous bone.

3.4
kerf
The notch or groove in bone, tooth, or cartilage made by an object that is edged, pointed, or beveled.

3.5
perimortem trauma
A skeletal defect that occurred when bone is in a biomechanically fresh (visco-elastic) state with no evidence of an osteological reaction.

3.6
plastic deformation
A permanent distortion of bone's shape without fracture caused by a force exceeding an element's elastic limit/elastic modulus/yield point.

3.7
postmortem damage
A skeletal defect that occurred after a bone has lost its biomechanically fresh (visco-elastic) properties.

3.8
projectile trauma
A skeletal defect often produced by high-velocity impact over a relatively small surface area, typically by projectiles from firearms, but can result from any small object impacting a bone at a high velocity.

3.9
sharp trauma
A skeletal defect produced by an object that is edged, pointed, or beveled.

3.10
skeletal trauma
A defect to osseous, dental, and/or cartilaginous tissue as a result of external forces.

3.11
spatial distribution
The locations of defects (or damage/breakage) in relation to each other throughout the skeleton.

3.12
thermal trauma
A skeletal defect produced by exposure to high temperature or direct contact with flame.

3.13
trauma description
Reporting of the location, dimension(s), and other observed characteristics of the skeletal defect(s).

3.14
trauma interpretation
Explanation regarding the mechanism, timing, direction of impact(s), and/or minimum number of impacts associated with skeletal defect(s) using quantitative and/or qualitative evidence

3.15
trauma mechanism
The external factors that produce a skeletal defect.

4 Requirements

4.1 General

Skeletal material shall be assessed and evidence of trauma and damage shall be documented before and after processing. The cranium should be opened and a complete endocranial examination conducted. Ideally, the endocranial examination should occur after ectocranial trauma is documented and other cranial data are collected.

When possible, skeletal trauma examination shall be based on gross, microscopic, radiographic, photographic, and/or other observations and analyzed using peer reviewed published methods. Documentation of trauma shall be adequate to allow independent verification of work performed in the absence of the originally analyzed material.

Documentation of skeletal trauma shall include written descriptions as well as visual representations (i.e., photographs, diagrams/sketches, radiographs, casts, 3D scanning). Descriptions shall include the location and characteristics of the skeletal defect. Trauma location shall be documented using standard osteological/anatomical terms. When multiple defects are present, the spatial distribution shall be documented and described. Dimensions of skeletal defects resulting from trauma should be measured, when appropriate.

Foreign material (e.g., hair, fibers, bullet fragments, blade tip) associated with a skeletal defect shall be documented and described. These materials may be collected and submitted for further analysis by other forensic science providers. However, analysis of foreign material is beyond the scope of this document.

A distinction shall be drawn between trauma description and interpretation. At a minimum, a description of the defect(s) shall be given. Trauma interpretation shall be limited to when the evidence supports the findings.

4.2 Trauma Timing

4.2.1 General

Defect characteristics shall be used to assess when the skeletal element was traumatized or damaged. Timing of the defect shall be classified using terms such as antemortem, perimortem, or postmortem. When a distinction in timing cannot be made between antemortem, perimortem, and postmortem, the limitations shall be clearly documented and reported.

4.2.2 Antemortem Trauma

Antemortem trauma shall be identified based on the presence of a trauma-related osteological reaction. These reactions may include healed fractures or evidence of healing, the development of pseudarthrosis, degenerative joint disease, or infectious response related to a fracture, a dental fracture with worn or rounded fracture margin, or a surgically implanted device.

Practitioners shall not provide a trauma interpretation for antemortem trauma except in cases that show identifiable features and patterning or radiographic evidence of identifiable foreign bodies.

4.2.3 Perimortem Trauma

Perimortem trauma shall be identified based on the presence of biomechanical characteristics indicative of fresh bone or the incontrovertible association of the trauma with the incident that produced it (e.g., explosion, fire, plane crash, fall from a building). Presence of biomechanical characteristics shall include: lack of osteological reaction, presence of fresh bone fracture characteristics, and absence of dry bone fracture characteristics. Classification of trauma as perimortem is strengthened when the mechanism or indicators can be identified (e.g., hair entrapped in bone with associated blunt trauma injuries, the presence of blood staining, or embedded debris from a fall from a building).

4.2.4 Postmortem Damage

Postmortem damage shall be identified based on differentially stained or recently exposed surfaces, absence of healing, characteristics of the break lacking biomechanically fresh (visco-elastic) properties, and changes resulting from taphonomic events.

When defects are classified as postmortem, terms such as “damage” and “breakage” should be used. The terms “trauma” and “fracture” should be reserved for antemortem and perimortem trauma.

4.3 Trauma Mechanism

4.3.1 General

Trauma mechanisms shall be based on defect shape and size, spatial distribution, and evidence of plastic deformation. Extrinsic, continuously variable and concurrent factors such as velocity and force may preclude the identification of a trauma mechanism. When the trauma mechanism cannot be identified, the defect shall be clearly described, documented, and reported without interpretation.

Fractured bones shall be re-approximated, and may be reconstructed, to clearly assess defect features and their spatial distribution. Fracture margins and fracture surfaces shall be examined prior to reconstruction and a reversible medium should be used. When possible, observed fracture patterns should be compared to reference material to aid in trauma mechanism classification.

No conclusions regarding defect sequencing shall be provided unless there are clear indications of the order of defects (e.g., a fracture terminating at a preexisting fracture).

4.3.2 Projectile Trauma

Observed features indicating projectile trauma may include: a projectile in association with the bone, entrance or exit defect characteristics (e.g., internal or external beveling), projectile residue, bullet wipe, remnants of the projectile, fracture pattern with minimal to no plastic deformation, and external beveling of concentric fractures in the cranial vault that indicates an internal to external force.

In the context of projectile trauma, plastic deformation may indicate a lower velocity projectile, a projectile slowed before impact, or other energy loss during flight.

When possible, entrance and exit defects shall include descriptions and photographs of internal and external beveling, defect measurement, anatomic location, associated fracture patterns (e.g., radiating and concentric fractures), and estimation of projectile path relative to anatomical position.

The presence of projectile residue (e.g., soot and other materials discharged from a firearm, staining from extended contact with metal, embedded metallic/radiodense artifacts) shall be documented. The term “bullet wipe” is preferred to “lead wipe,” since the outer surface of a bullet may be composed of materials other than lead.

Practitioners shall not estimate or report bullet caliber. Estimates of muzzle to target distance shall be made with caution and supported by skeletal findings. Practitioners should describe the spread of shotgun pellets, presence of wadding, or shot cup, which may be informative of distance.

4.3.3 Blunt Trauma

Observed features of blunt trauma may include: fracture patterns (e.g. wedge, buckle), plastic deformation, delamination, internal beveling of concentric fractures in the cranial vault indicative of external to internal force. Features of an impact site (i.e., depressed fractures, circumferential fractures, tool marks) shall be documented. Staining, which may result from blood and fat within crushed diploe, and other alterations which may represent impact sites shall also be documented.

The use of standard clinical terms (e.g., Parry, Colles) and orthopedic classification systems (e.g., Le Fort, Salter-Harris fractures) should be used with caution to avoid non-skeletal implications or interpretation.

An interpretation of the minimum number of impacts and direction of impact(s) should be documented, when possible.

4.3.4 Sharp Trauma

Observed features of sharp trauma may include: straight-line incised defects, punctures or gouges, chop or hack marks (clefts), and kerfs. Defect features such as length, width, depth, and inter-striation distance should be measured, and casts made when possible. Sharp trauma defects and their casts shall be examined grossly and microscopically.

Defect features may reflect class characteristics of the tool and shall be interpreted to identify tool type/class. Dismemberment should be considered when interpreting sharp force trauma, particularly if the extremities and/or head are affected.

Fractures can occur in association with sharp trauma and shall be documented, if present. Features common with pseudo-sharp trauma, such as scrapes, scores, and scratch marks, shall be documented. Tool marks in bone or cartilage shall not be identified as hesitation marks.

4.3.5 Thermal Trauma

Observed features of thermal trauma may include: color changes (e.g., yellow, black, white), delamination, burn pattern, shrinkage, charring, calcination, or heat-related fracture patterns. Thermal fracture location(s) and type(s) shall be documented. Features indicating that the bone was biomechanically dry during burning (e.g., absence of warping) shall be documented. When thermal trauma and other trauma (e.g., sharp, blunt, projectile) coexist, all trauma types shall be clearly delineated in the documentation. Aberrant patterns of burning (i.e., patterns that are inconsistent with those expected due to tissue shielding) may provide information about body positioning, presence of trauma (e.g., dismemberment), or postmortem interval (e.g., lack of pugilistic posture) and shall be documented.

Practitioners shall not estimate the temperature or duration of heat exposure based on thermal defects to bone.

5 Considerations and Adjustments

The term “perimortem” is used differently by pathologists and anthropologists. The timing of injury is less precise when evaluating bone than when evaluating soft tissue. Based upon the intrinsic properties of bone, the perimortem interval extends from days preceding death to days to weeks

following the death event. When perimortem trauma is identified, a forensic anthropological definition of "perimortem" should be included in the report.

Practitioners may estimate the minimum number of traumatic events (e.g., blunt impacts, projectile entry defects, or sharp defects) observed skeletally, but shall not report a definitive maximum number of impacts, as skeletal trauma evidence may not reflect all impacts to the body.

The spatial distribution of fractures shall be considered to evaluate whether the fractures occurred from a single impact/event (e.g., a fall resulting in serial rib fractures).

Factors that may influence skeletal trauma (e.g., decedent age, sex, health status; bone and fracture type; fracture location) shall be considered in skeletal trauma interpretation. These factors are particularly important when assessing age of injury. For example, an adult healing phase assessment shall not be applied to an infant.

Pathological conditions, anomalies, or taphonomic changes may mimic skeletal trauma.

Practitioners shall not determine a “match” between a specific tool and a tool mark.

Forensic anthropologists shall not determine cause or manner of death.

Blasts/explosive events often cause blunt (including concussive) and projectile trauma to the body. When the trauma pattern is consistent with a blast event, the trauma mechanism should be classified as "blast trauma”.

6 Reporting

The written report shall include the methods used and descriptions of gross, microscopic, and radiological findings that are referenced in support of a trauma interpretation. Trauma location and spatial distribution as related to anatomical position shall be reported.

Interpretation of trauma and its timing may not be possible due to the nature of the trauma or the condition of the skeletal material; equivocal results shall be reported as such. Trauma interpretation shall be clearly identified in the report using terms such as ‘indicative of’ and ‘consistent with’ or by using a subheading titled ‘Interpretation’.

When a suspect tool is submitted for analysis, similarities between the tool and defect may be reported; conclusions shall be reported in terms of an exclusion or failure to exclude.

Reporting shall avoid terminology that may be considered inflammatory, imply a particular outcome, or imply intent. Terms to avoid include but are not limited to: victim, weapon, violent, painful, suffer, and lethal.

When casts are made of traumatic defects, the method, materials, and any artifacts created, as well as the final disposition, shall be documented in the report or case file. When physical evidence is collected from a traumatic defect (e.g., a projectile, blade tip), the disposition of the evidence shall be documented.

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