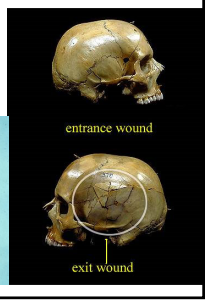
Trauma

TEXAS STATE®
FORENSIC ANTHROPOLOGY CENTER

1

Trauma Analysis

- Aids in determining the manner of death
- Differentiate antemortem, perimortem, and postmortem damage



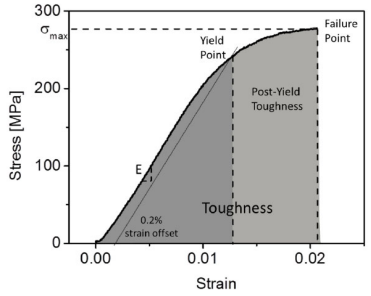
2

Trauma

- Trauma
  - "Physical injury or wound caused by external force or violence"
- Types of Trauma
  - Blunt – impact by or with blunt object
  - Projectile – bullet etc.
  - Sharp – knife etc.
  - Fire – extreme heat
  - Chemical – acid etc.

3

Mechanical Properties



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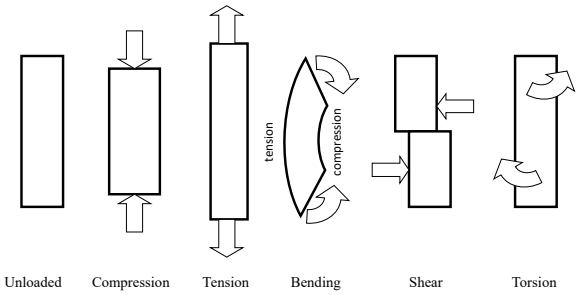
Types of Force



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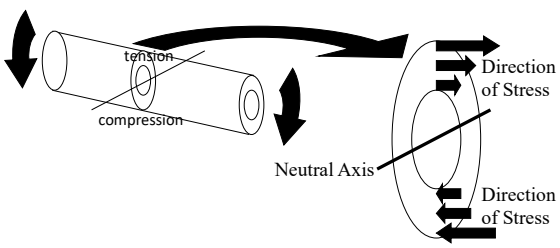
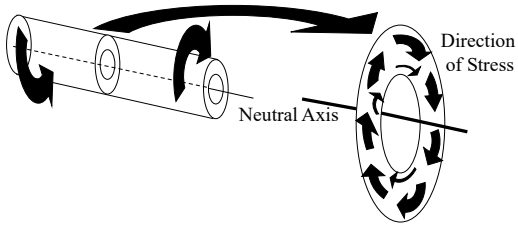
Bone Undergoing Bending



6

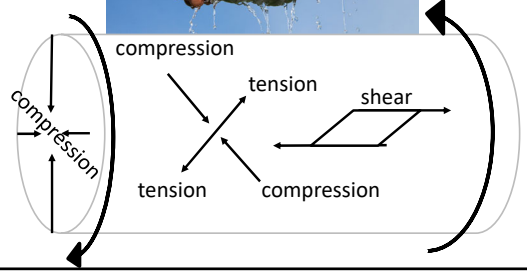
Bone Undergoing Torsion



Tension & compression at 45 degree angle to longitudinal axis and shear force in transverse plane

7

Torsion



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Stress & Strain

- Stress – intensity of load per unit area
- Strain – amount of dimensional change in shape
- Bone will fail when the strain becomes to great regardless of the level of stress.

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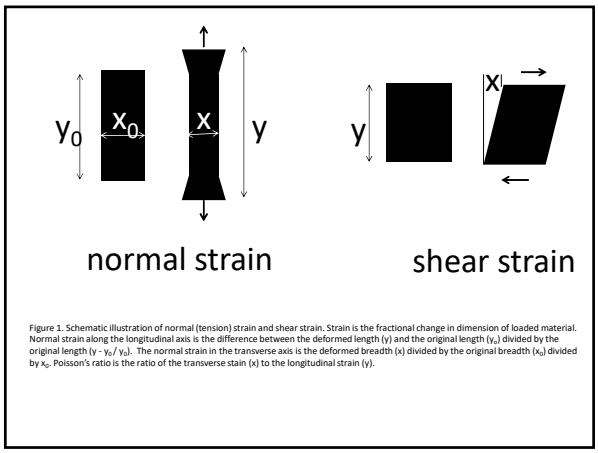

Figure 1. Schematic illustration of normal (tension) strain and shear strain. Strain is the fractional change in dimension of loaded material. Normal strain along the longitudinal axis is the difference between the deformed length (y) and the original length (y_o) divided by the original length ($y - y_o / y_o$). The normal strain in the transverse axis is the deformed breadth (x) divided by the original breadth (x_o) divided by x_o. Poisson's ratio is the ratio of the transverse stain (x) to the longitudinal strain (y).

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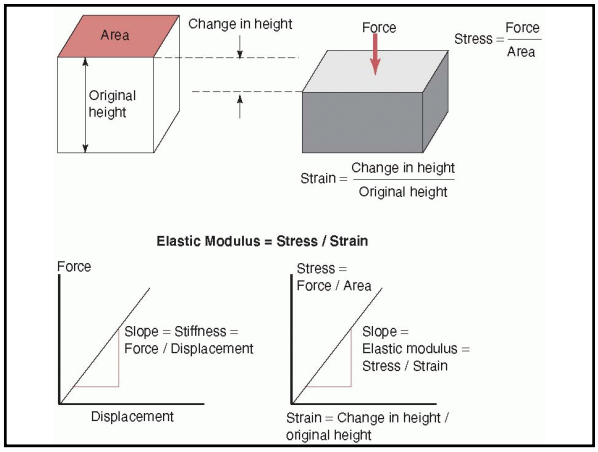

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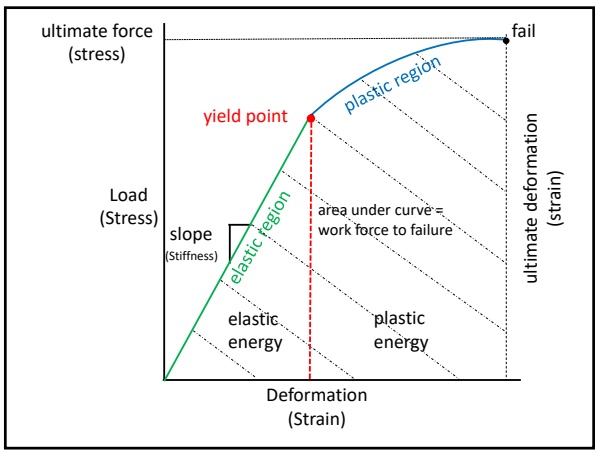

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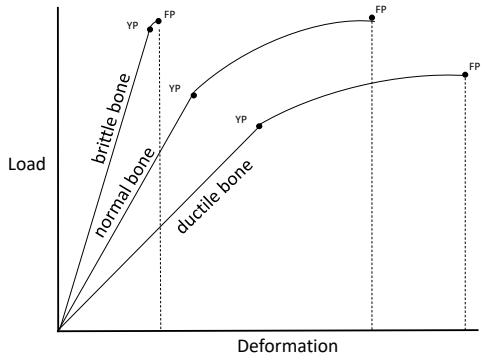

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Trauma analysis fracturing

If the strain surpasses the ultimate strain the bone will fail

Bone is weakest in shear, then tensile, then compression

Fractures will start along shear or tension stresses

Fractures follow the path of least resistance

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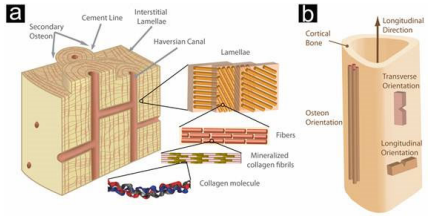
Material Properties of Bone

- Bone is a composite material with anisotropic and viscoelastic characteristics
- Anisotropic characteristic



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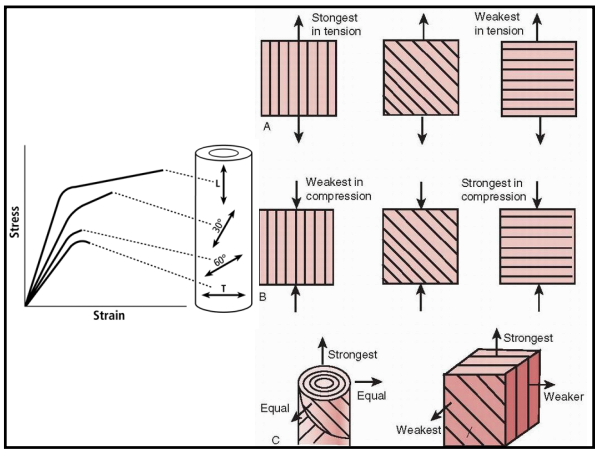

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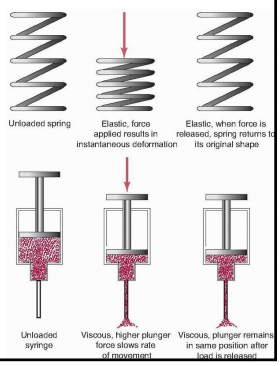
Viscoelastic

- Elastic
  - Deforms under load
  - Returns to original shape when load released
- Viscous
  - Creep – does not return to original shape when load released
  - Rapid application of force causes greater resistance to motion (increased stiffness)



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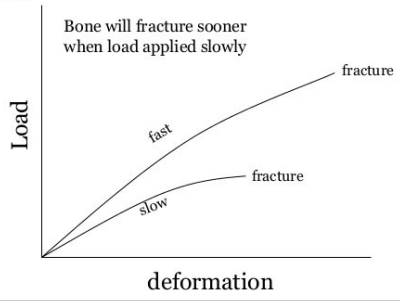
Visco-elastic Response

Behavior of bone is dependent on *rate at which* load is applied.



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Trauma analysis blunt force trauma

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Blunt Trauma

- Fracture
  - Complete break in bone
- Infraction
  - Incomplete break of a bone in which the parts do not become displaced

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Energy absorbing mechanisms

- Contraction of muscles
- Deformation of soft tissue
- Deformation of bone
- Clothing

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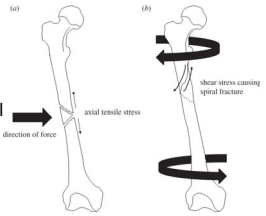
Fractures

- Bone affected
- Location
- Shape
  - Oblique, transverse, spiral
- Complete or incomplete
- Types and areas of force
- Healing



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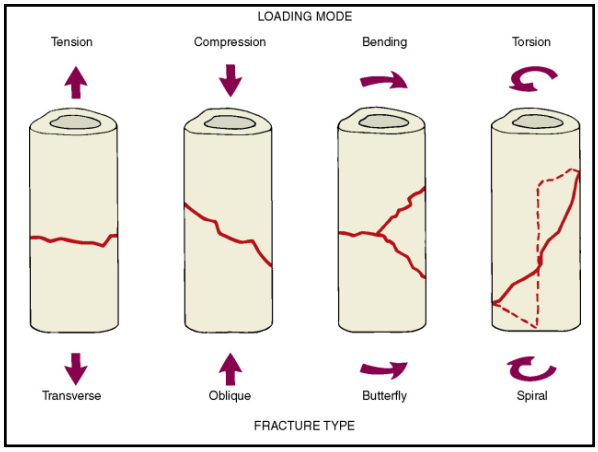

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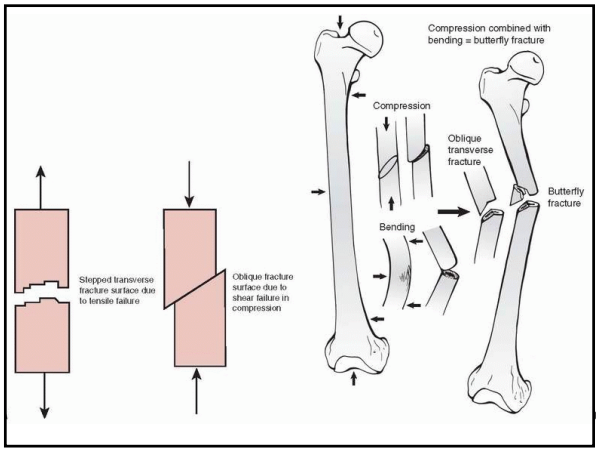

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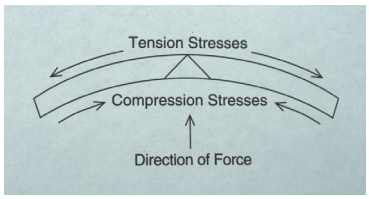
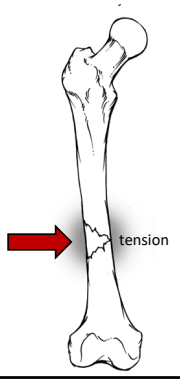
Direction of Force





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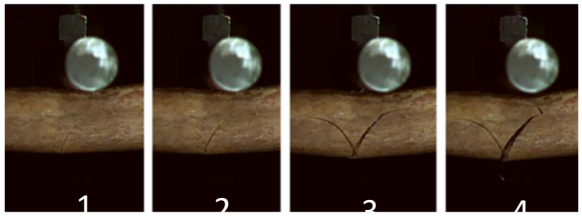
3-point bending



Stills from the high-speed video of impact experiment.
Frame 1: tensile initiation.
Frame 2: branching of incomplete and complete fractures.
Frame 3: failure angle shifts.
Frame 4: formation of breakaway spur.

From Isa et al 2017

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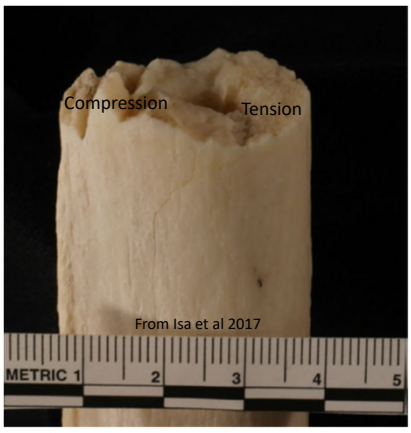

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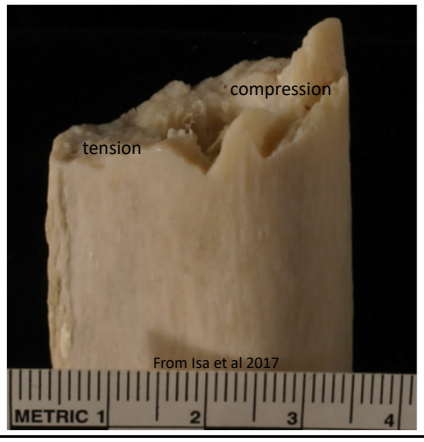

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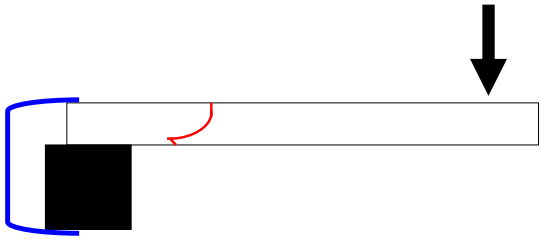
Hinge Fracture

Force



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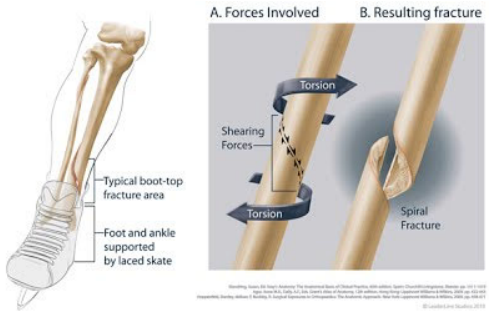
Trauma analysis fractures



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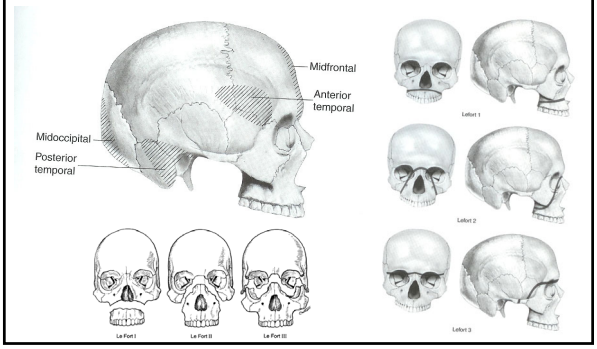
Trauma analysis



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Blunt Trauma

- Need to evaluate 3 traits of the object causing blunt force trauma
  - Size
  - Shape
  - Weight
- Need to evaluate characteristics of the force
  - Type of force (tension, compression, etc)
  - Direction
  - Energy

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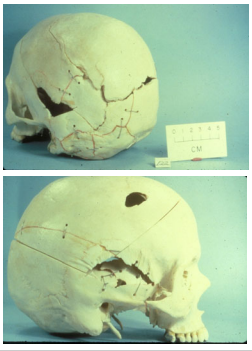
Object Characteristics

- Size
  - Length & Width
  - Long & narrow objects require less force to cause bone failure (fracture)



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Object Characteristics

- Shape
  - Round
  - Angular
  - Patterned injuries

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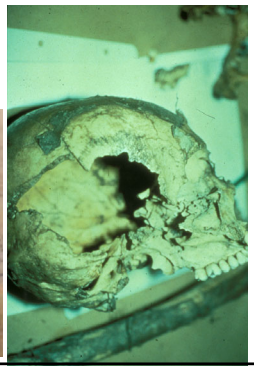
Object Characteristics

- Weight
  - Light – fewer fracture lines



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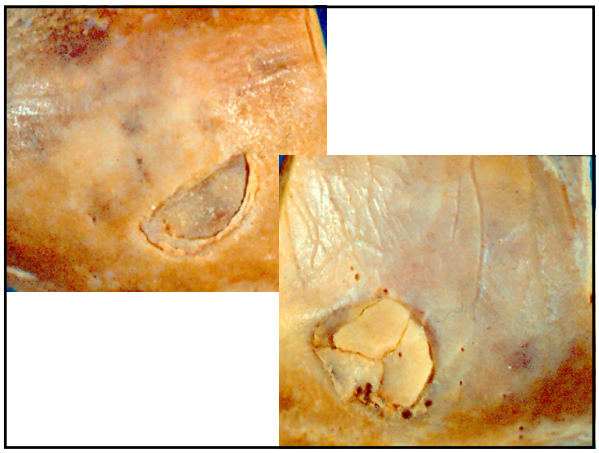

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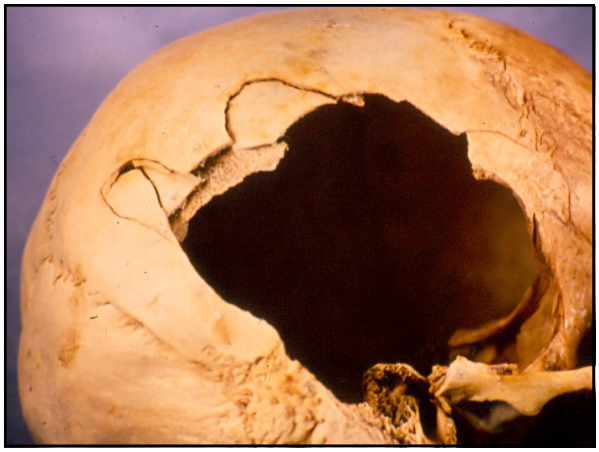

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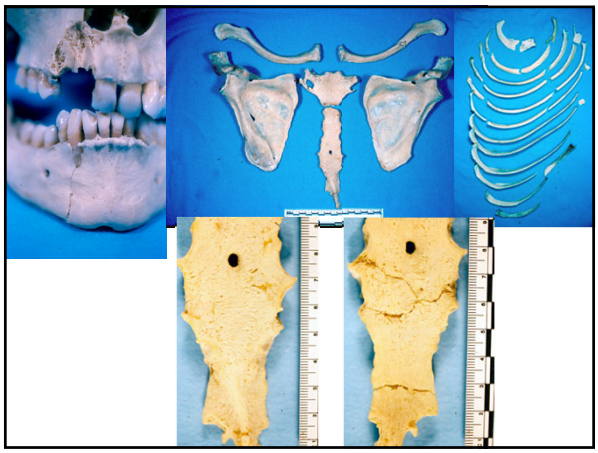

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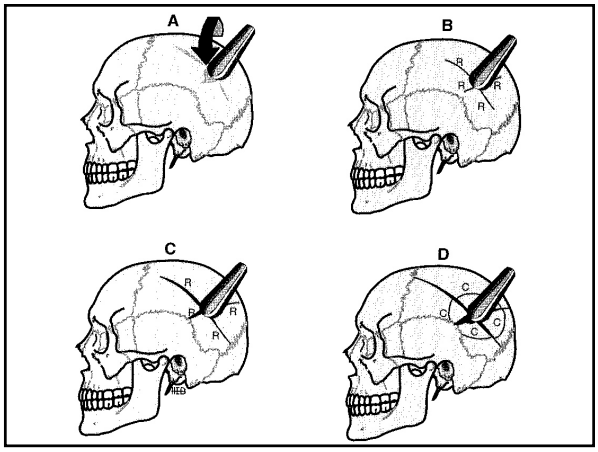

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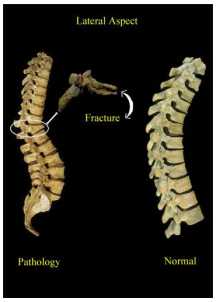
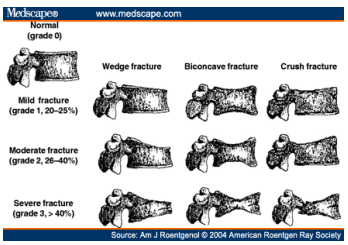
Vertebral Fractures





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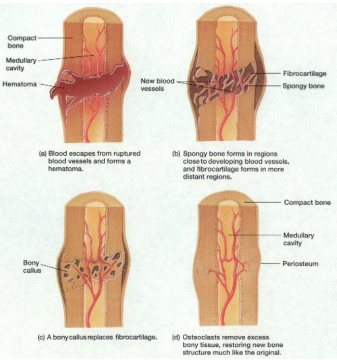
Fracture Healing



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Fracture Healing

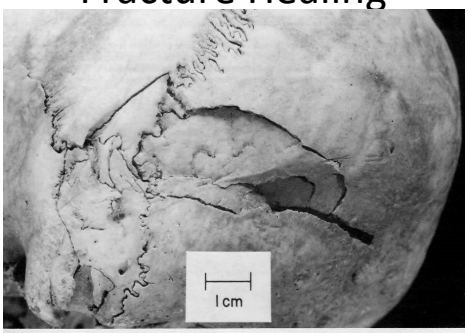

Figure 72a. Perimortem depressed cranial fracture just posterior to asterion on the left side of the occipital bone. Specimen from Burial 239-242, Norris Farms 36, central Illinois. Previously published as Figure 1 in *American Antiquity* 56(1991):581-603. Courtesy of G.R. Milner and the Society for American Archaeology.

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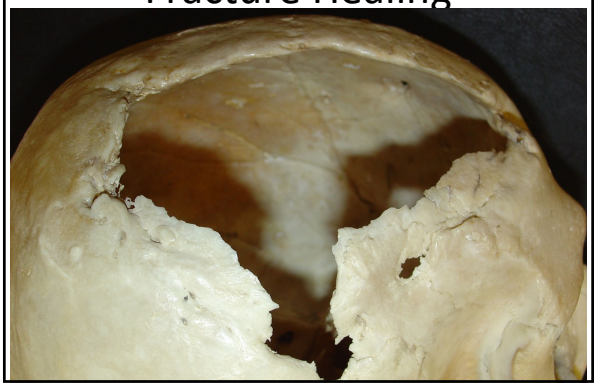
Fracture Healing



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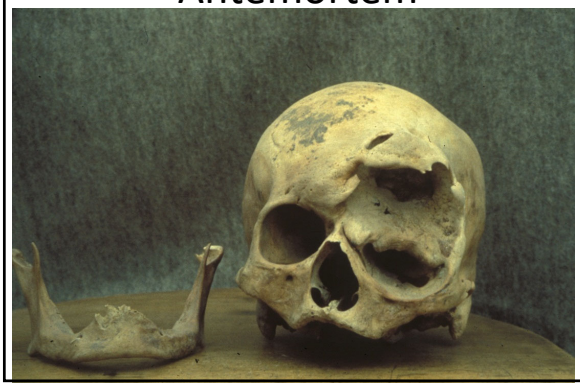
Antemortem



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Fracture Healing

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Fracture Healing


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Fracture Healing


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Postmortem Fracturing

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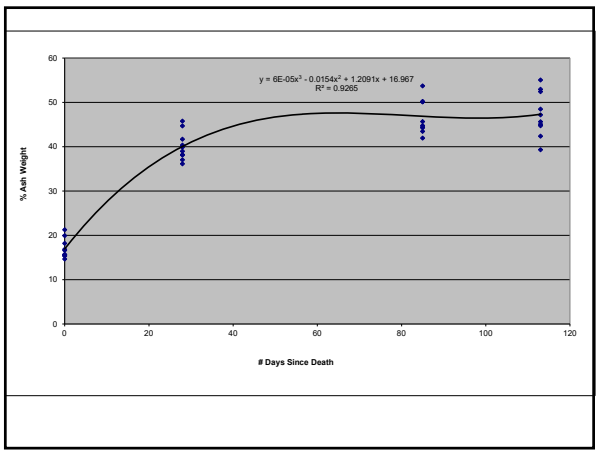

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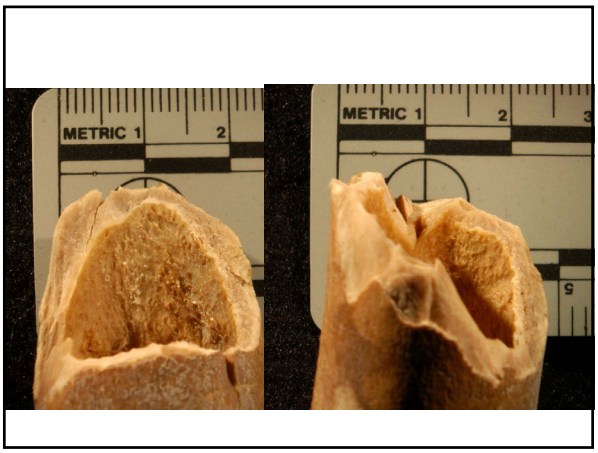

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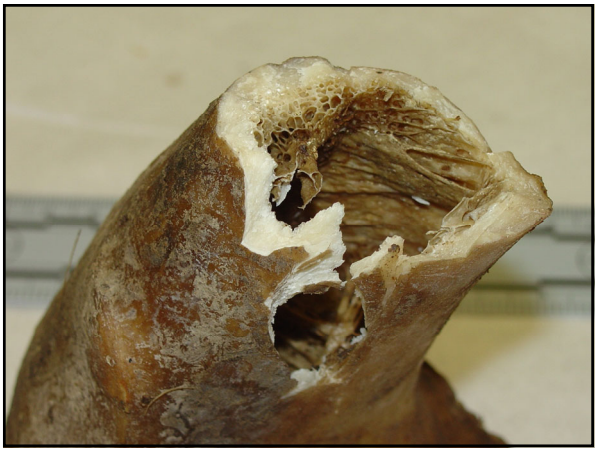

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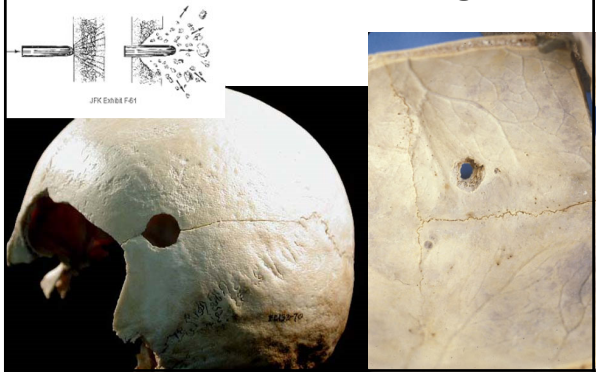
Direction: Beveling



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Direction: Beveling

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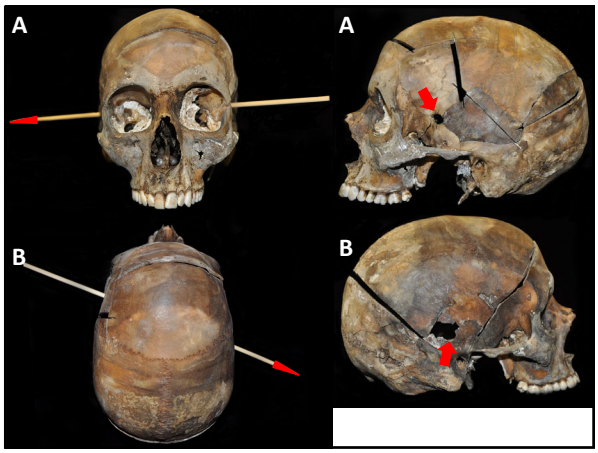

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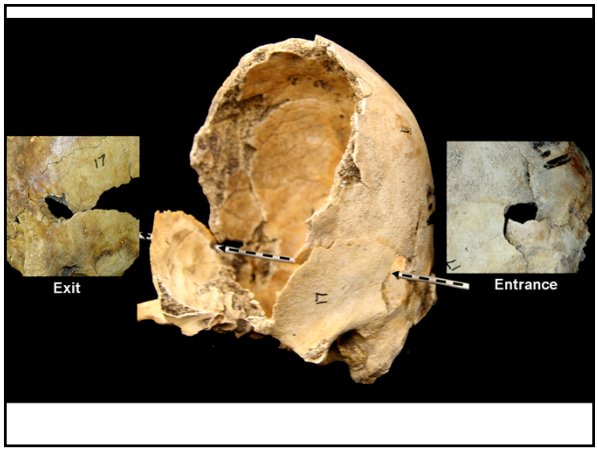

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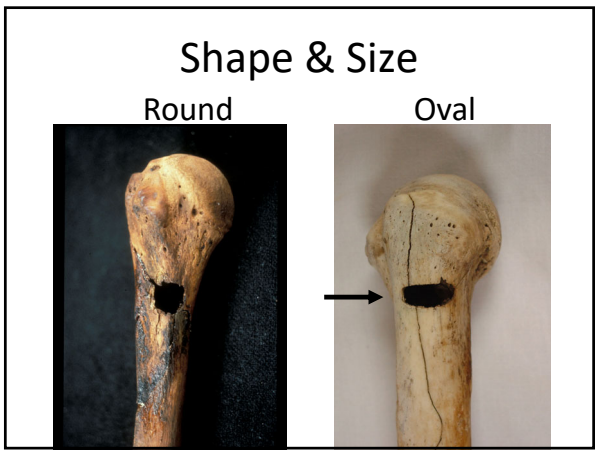

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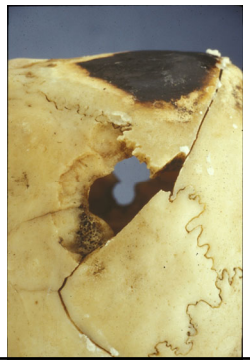
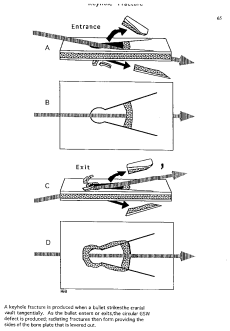
Shape and Size





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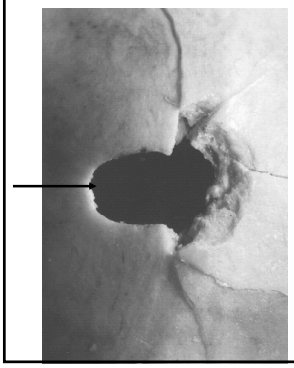
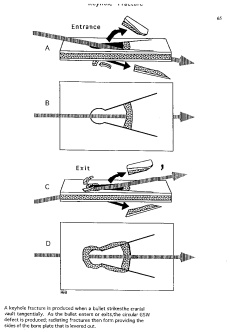
Shape and Size





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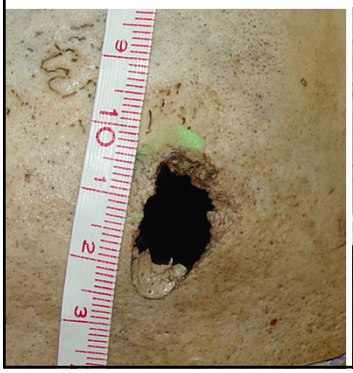
Gunshot Wound



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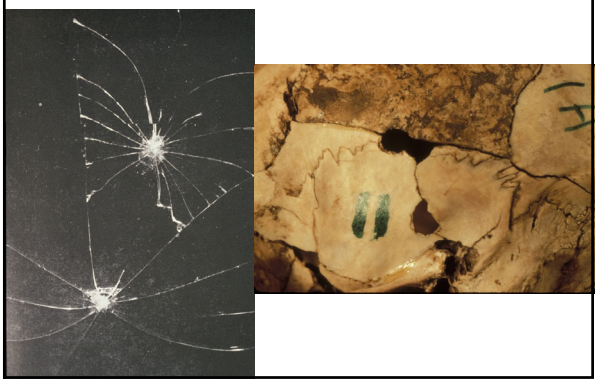
Gunshot Wound



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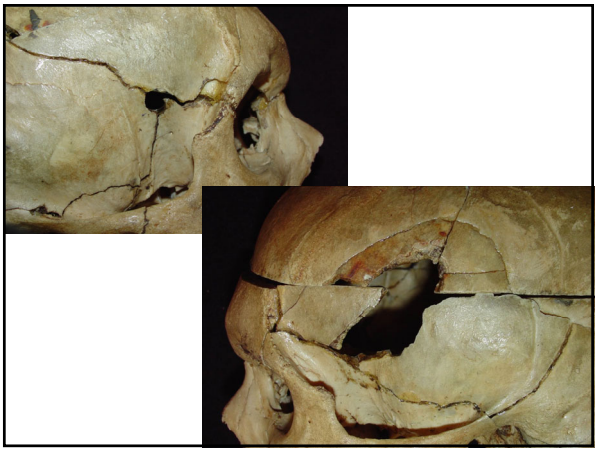

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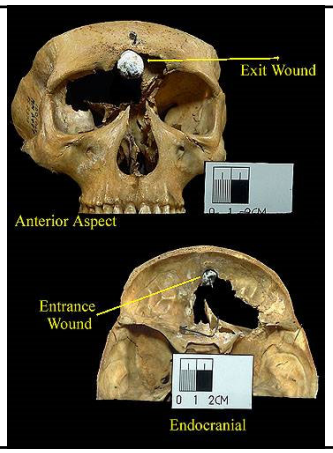
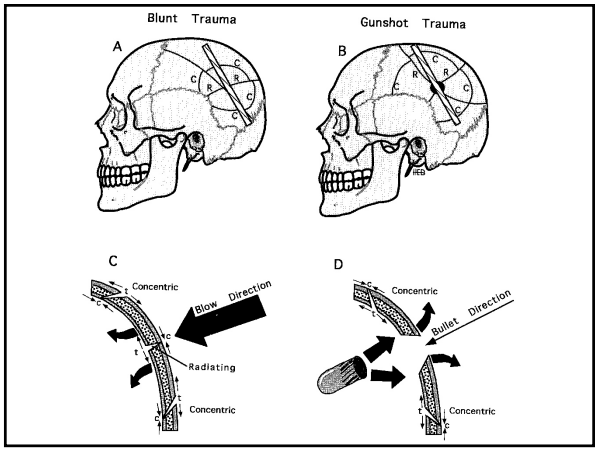

Exit Wound
Anterior Aspect
Entrance Wound
0 1 2CM
Endocranial

70


Blunt Trauma
Gunshot Trauma
A
B
C
D
Concentric
Blow Direction
Radiating
Concentric
Concentric
Bullet Direction
Concentric

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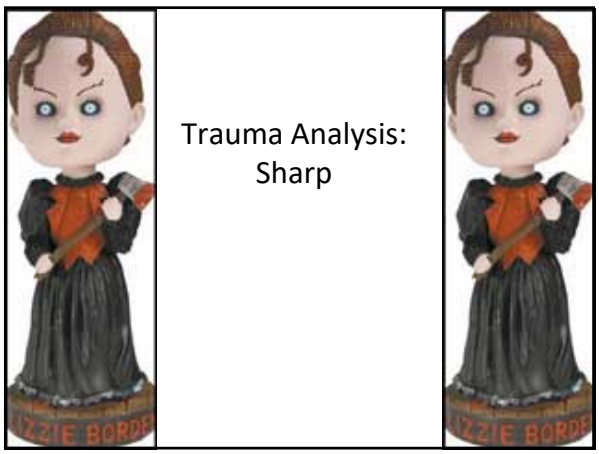
Trauma Analysis:
Sharp

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Sharp Force Trauma

- Narrowly focused compression force
- Common instruments
  - Knife, axe, ice pick, chain saw, etc.
- Discontinuity
  - Incision
  - Chop or Cleft
  - Puncture

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Sharp Force


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Sharp Force Trauma

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Decapitation

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Dismemberment

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Saw Kerf Analysis

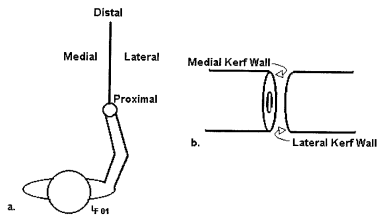

Figure 2. Orientation of directional terms used in this study. (a) is an over head view of a person holding a saw, and the relevant directional terms. (b) is a diagram of a hypothetical kerf, viewed from the perspective of the sawyer.

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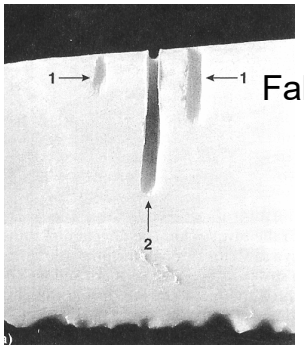
Saw Cut Morphology



False Start

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Saw Cut Morphology

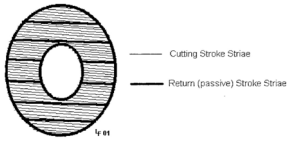
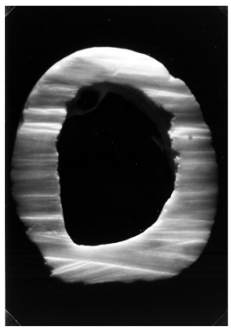


Figure 1. Schematic drawing of the recurring pattern of fine cutting stroke striae between coarser return (passive) stroke striae.



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Burned Remains

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The Fire Triangle

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Pugilistic Pose

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Classic burned bone case

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Burned bone examples

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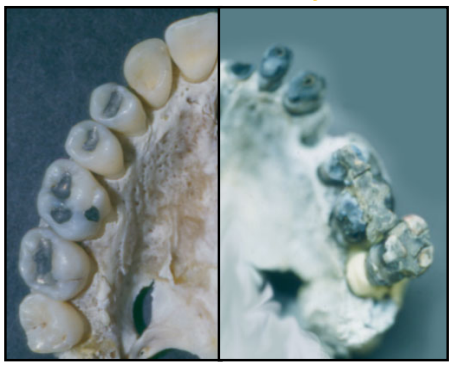
Dental Analysis



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Dental Analysis

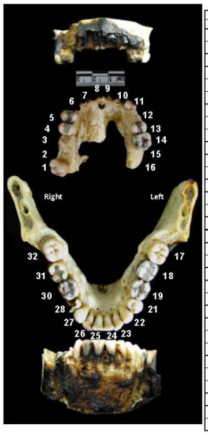

Table 1: Dental Inventory	
Tooth	Characteristics
1	Present
2	Absent antemortem
3	Absent antemortem
4	MO amalgam restoration
5	MOD amalgam restoration
6	Absent heat induced
7	Absent heat induced
8	Absent heat induced
9	Crown Absent heat induced
10	Crown Absent heat induced
11	Crown Absent heat induced
12	Absent antemortem h
13	MOD amalgam restoration
14	DOLB amalgam restoration
15	Absent antemortem
16	Absent antemortem
17	Present
18	Complete Stainless Steel Crown
19	OB amalgam restoration
20	Absent antemortem
21	Present
22	Present
23	Present
24	Present
25	Present
26	Present
27	Present
28	Crown damage
29	Absent antemortem
30	DOB amalgam restoration
31	MO amalgam restoration
32	Present

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Types of Fractures

Green, Dry or Burned:

- Spiral/Oblique
- Longitudinal
- Step
- Transverse
- Splintering

Burn Specific:

- Patina
- Delamination
- Curved Transverse
- Burn Line Fracture

Symes et al 2008

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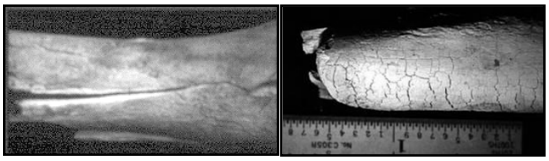
Heat Alteration of Bone



Longitudinal

Patina

Straight Transverse

Curved Transverse

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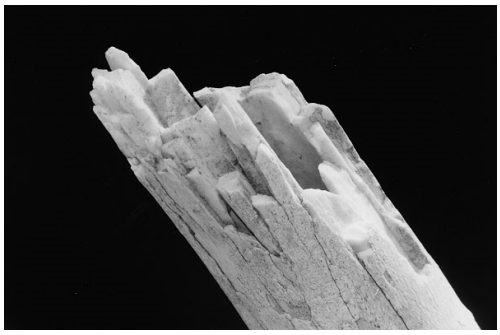
Splintering



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Curved Transverse Fractures

- Symes et al. (2008) suggest that such fracture may indicate direction of heat

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Shrinkage

- Experimental studies have suggested as much as 37% shrinkage (Thompson 2005)
  - Shrinkage significant at temperatures more than 800 °C

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Warping

- Plastic deformation of the bone – possible explanations:
  - caused by the stress and strain due to shrinking muscle tissue and periosteum
  - Reorganization of the inorganic component (crystalline structure) as a result of the loss of organic component in bone

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Trauma-Induced Spiral Fracture

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Sharp Force Trauma

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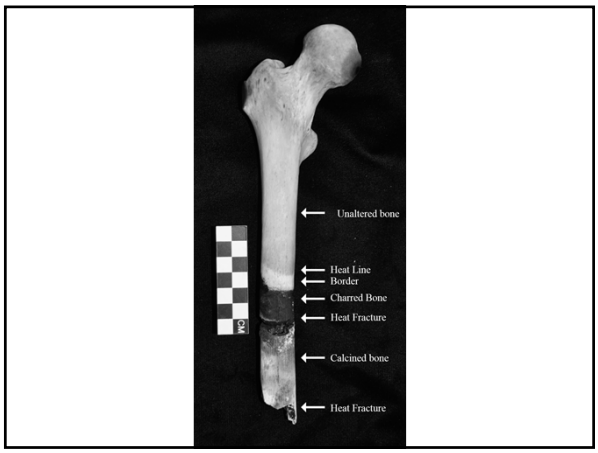

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Taphonomy

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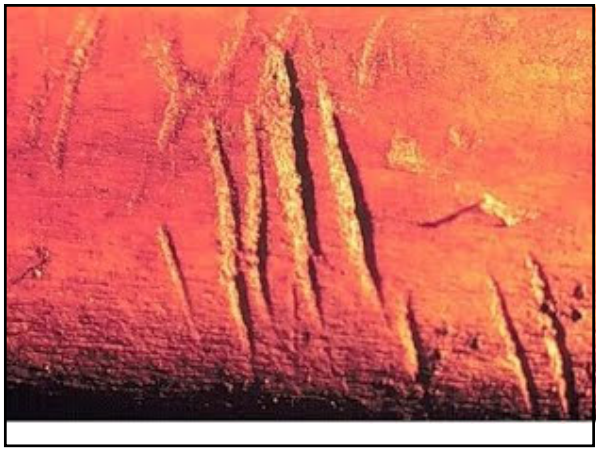

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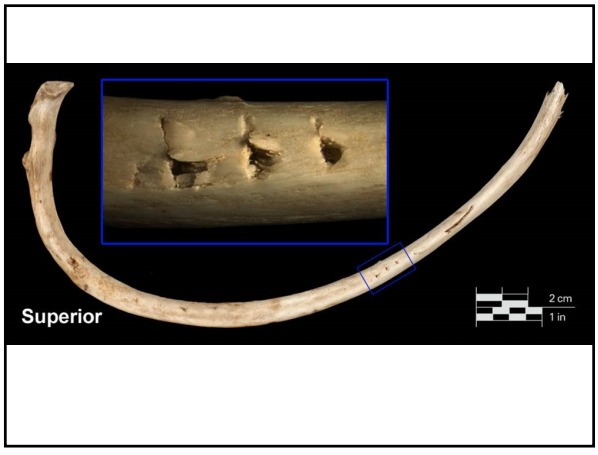

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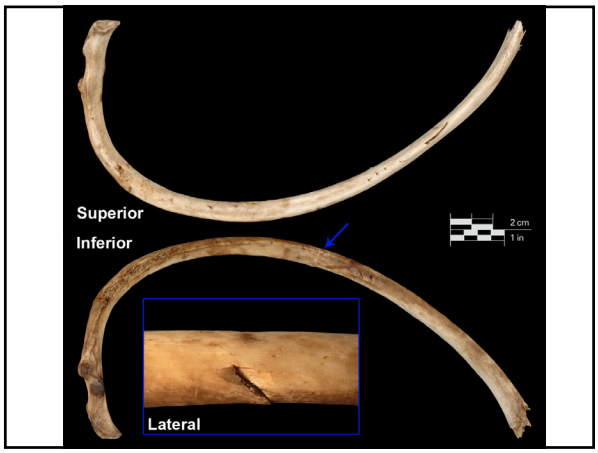

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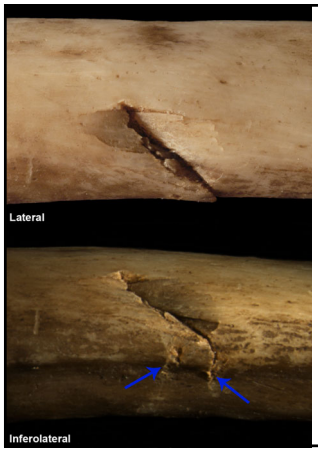

- Postmortem damage
- Probably small carnivore

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