

Transition Analysis 3 (TA3)

Trait Manual

Public Distribution Draft (Ver. 1.0)



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GENERAL INFORMATION

Materials for Skeletal Scoring

- trait scoring manual
- data collection form
- metric ruler
- osteometric board (not pictured)
- digital scale (not pictured)
- sticky notes
- portable light source
- soft-bristled toothbrush and toothpick
- gloves



Trait scoring manual: Contains detailed trait descriptions, including location, possible scores, and examples. The manual should be read carefully before starting data collection, and referred to often.

Data collection form: Whenever possible, record data in hard copy, as opposed to directly into the computer. Paper data forms decrease scoring time and potential error in the field where costs are high and time is limited.

Metric ruler or calipers: Some traits have specific thresholds in millimeters.

Osteometric board and scale: An osteometric board and scale capable of measuring in grams are necessary to collect standard measurements and weights for several bones.

Portable light source: Adequate lighting is critical for observing traits. Features that can be easily seen in angled light disappear in diffuse fluorescent lighting or dim conditions. Even in good lighting, a focused light source (e.g., flashlight or lamps) can be used to highlight specific features, such as eburnation on the facet of C1 or residual billows on the pubic symphyses.

Sticky notes: Data collection is undertaken without prior knowledge of the age and sex of the individual. Opaque sticky notes, which are temporary and non-damaging, are a good option to cover information located on the outside of storage containers.

Soft-bristled toothbrush and wooden toothpick: These can be used to remove dirt or other loosely adhering material.

Gloves: Latex or nitrile gloves are not typically required for handling human skeletal material. Occasionally, hair, grease, adipocere, or other substances, such as mineral deposits, may warrant the use of gloves if desired. Individual museums or agencies, particularly those in medicolegal settings, may have their own policies regarding the use of gloves when handling human remains.

Using the Trait Manual

Types of Features

All features are considered non-metric because they are scored as binary features or as one of several discrete ordinal categories. Features can be divided into three broad categories:

1) Descriptive features.

- Features are present or absent based on characteristics outlined in the definition.
- Example: Parietal bone depression is scored based on its overall appearance.

2) Features with non-metric thresholds.

- The threshold for a feature to be present involves a number of features or a fraction or percentage of a defined area.
- Examples: The lateral articulation surface of the clavicle must have three or more macropores to be present. Bumps must cover one-third of the anterior surface of the lesser tubercle of the humerus to be present.

3) Features with metric thresholds.

- Cutoff points for a trait can take the form of a single measurement (e.g., length), two measurements (e.g., length and width), or an area (e.g., a rectangle).

Two Measurements

Example shapes:

Trait example:

Ischial tuberosity superior margin spur. The ossification can take any of the above shapes as long as its base and length reach the required dimensions. (ID#:2460). Image reversed.)

One Measurement

Example traits:

Thoracic vertebral lipping. Lipping must extend outward or upward $\geq 5\text{mm}$ at one or more points. (ID#:2678)

Ischium medial spur. (ID#:2460)
Image reversed.

Trapezium lipping. Lipping must extend away from the original articulation surface $\geq 2\text{mm}$ at two or more points. (ID#:2237)
Image reversed.

Area

Example shape:

Trait Examples:

Rib 2 cap. To be present, the cap must extend away from the bone surface by $\geq 1\text{mm}$ along $\geq 3\text{mm}$ in length (forming a rectangle). (ID#:2182)

Fibula wings - medial surface view. (ID#:2325)

Definition Terminology

Traits are defined using the simplest terms that describe the feature to be scored (i.e., bony spur rather than enthesophyte). Our aim is to present the features in the clearest way possible for an international readership, and ensure that individual observers score features the same as defined in the reference data.

To apply this method correctly, the most critical observation is the correct classification of the presence or absence of the trait. For the purposes of trait scoring, the discussion should be “are the bumps present or not”, instead of “are the bumps exostoses and what caused them”. Future research will build on the biological basis of trait formation.

Trait Examples & Captions

- Photographs illustrate clear examples of each trait category, individuals where morphology may be ambiguous, and scoring exclusions.
- Each caption begins with the trait category the photo represents in **bold**.
- Descriptions provide additional information about feature classification.
- Each photograph is designed with a random individual identifier. The specific individual can be identified by contacting the research team.

Scoring & Data Collection

Scoring Features

Features should be scored individually regardless of the other features found in the skeleton. In other words, an old characteristic in an individual with otherwise young features should be scored as *present* if it truly meets the definition criteria.

If grossly observable trauma (e.g., a healed distal fibula fracture) or pathological lesion is present, features should not be scored in that area. Traits should still be scored in other parts of the skeleton. The choice to exclude (not score) a feature is based on whether the area to be scored is affected by some pathological or traumatic process. Decisions are **not** based on the observer's feeling that the trait is consistent with the skeleton's presumed age or other scored features.

The trait scoring manual should be consulted frequently to ensure that traits are scored properly.

Notes on Data Collection

After all data have been collected, the form should be checked to verify that:

- All header information is complete – skeleton ID number, initials of observers, time, date, and estimated sex.
- There are no blank fields on the form and all fields have, at most, one item circled (e.g., a trait cannot be both absent and present).
- Circled fields are consistent and age-appropriate. If a trait is anomalous, it should be verified and noted on the form. For example, an adult with an unfused speno-occipital synchondrosis should raise a red flag. If the scoring is correct and still seems odd, add a note indicating that the peculiarity was checked.
- The skeleton ID number is on the front and back of the form, and these numbers match.

BEWARE OF DEFINITION CREEP!

definition creep – the gradual broadening of trait definitions over time, resulting in the unintentional inclusion of most individuals

Observers tend to change definitions gradually over time. Typically, this is a shift towards including minor expressions of a trait as present. In this method, most traits, when present, are obvious with a quick look at the bone. If you are unsure, the trait is likely absent.



Consult the manual frequently.

Don't let definition creep happen to you!

CRANIUM

Parietal depression [bilateral]

Location: the parietal bone between the superior temporal line and the sagittal suture (PD Fig. 1)

Scores: 0. absent 1. present

Absent: The parietal bone contour is rounded or flattened, but not depressed (PD Fig. 2 a,b).

Present: A portion of the parietal bone is slightly depressed (concave) relative to its normal contour. A depression is most often a rounded or oval area located on the middle to posterior portion of the parietal bone. Less typically, the depression can be expressed as a long groove, two or more centimeters wide, just superior to the temporal line.

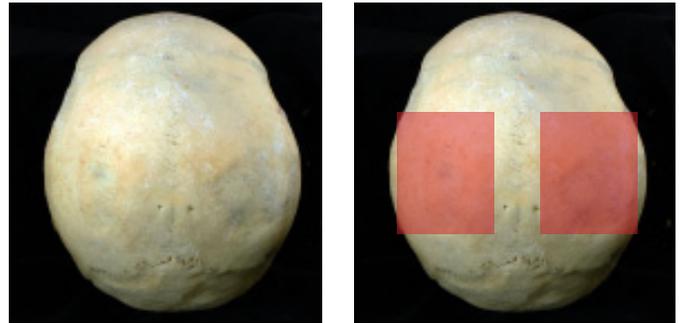
Notes:

- The contour of the parietal bones is most easily assessed in a posterior view. However, depressions can often be seen in a superior view, particularly when the bone where the depression is located is particularly thin (e.g., PD-5, PD-7)
- Depressions can be subtle, asymmetric, and may occur unilaterally.
- Robust parietal bosses, well-developed temporal lines, sagittal keeling, or a combination of these features can cause parietal bones to appear depressed. Take care to differentiate these features from parietal bones that are depressed relative to the normal contour of the parietal bone.
- Well-healed cranial trauma (unilateral or bilateral) is distinctively different than parietal thinning and should not be scored.

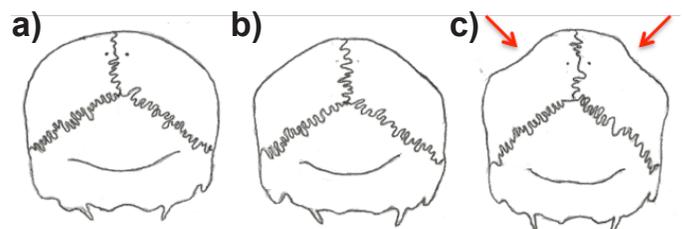
Examples:



PD-1. Absent
Posterior view. The parietal bones are rounded. (ID#:1566)



PD Fig 1: Parietal depression scoring location



PD Fig 2: Parietal bone contour variants: a) round, b) flattened, c) depressed.



PD-2. Absent
Posterior view. The right parietal bone is flattened. (ID#:1831)



PD-3. Present
Posterior view. Subtle bilateral depressions. (ID#:2719)



PD-4. Present
 a: posterior, b: superior oblique. Bilateral depressions.
 (ID:#1384)



PD-6. Present
 a: posterior, b: superior. Bilateral depressions. In the superior view, the depressions are distinct in both color and contour.
 (ID#:1781)



PD-5. Present
 a: posterior, b: oblique superior-posterior. Bilateral asymmetric depressions. (ID#:2051)



PD-7. Present
 a: posterior, b: superior. Extremely deep, bilateral, asymmetric depressions. (ID#:1592)

Spheno-occipital synchondrosis

Location: the region where the basilar portion of the occipital bone and the sphenoid meet (SO Fig. 1)

Scores: 0. open 1. closed

Open: Any gap between the sphenoid and occipital visible on the external surface of the basicranium.

Closed: There is no evidence of a transversely oriented groove transversely oriented groove where the occipital and sphenoid bones meet.

Notes:

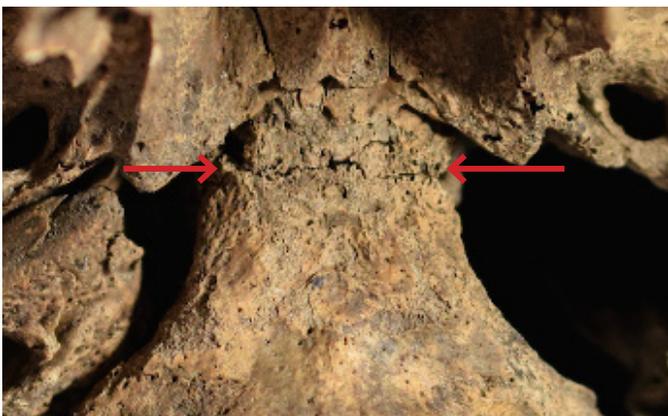
- The overwhelming majority of individuals will be fully fused.
- Postmortem breaks in this region may imitate an open or partially fused synchondrosis (e.g., SO-3).
- Small vascular impressions and surface irregularities can exist on the external surface of a closed spheno-occipital synchondrosis. These grooves should not be mistaken for incomplete fusion (e.g., SO-5)

Examples:



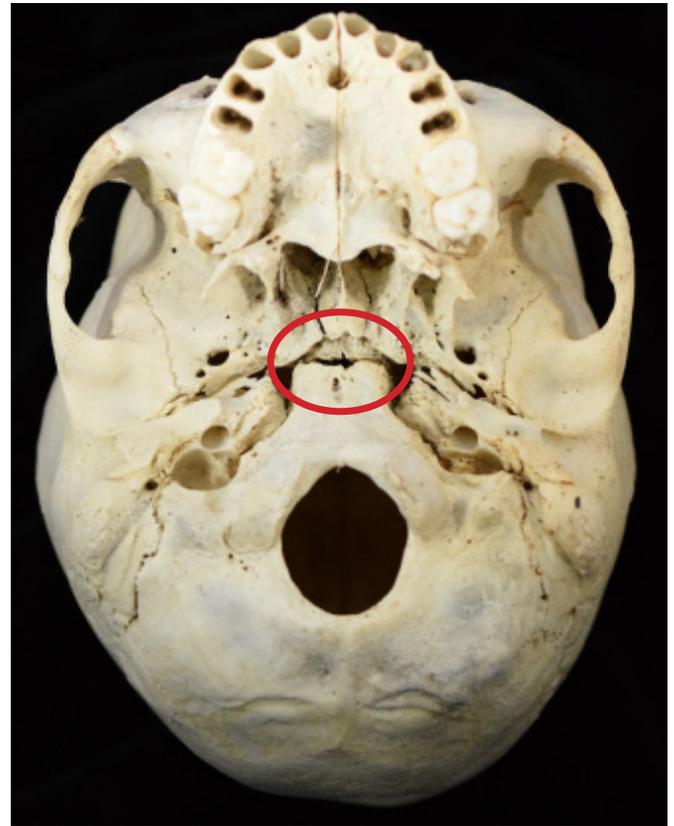
SO-1. Open

The synchondrosis is completely open with small foramina visible on the basioccipital posterior to the open synchondrosis. (ID#: 1758)



SO-2. Closed

The synchondrosis is completely fused, but a postmortem break is present in this area. (ID#:2721)



SO Fig. 1: Location of spheno-occipital synchondrosis. (ID#:1758)



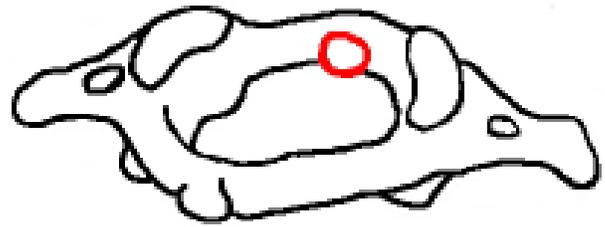
SO-3. Closed

Small vascular impressions that can occur in this area (circled) should not be confused with an open, or partially open, synchondrosis. (ID#:1826)

VERTEBRAE

C1 lipping (1st cervical vertebra dens articulation surface lipping)

Location: the edges of the articulation surface for the dens (odontoid process) on the posterior surface of the anterior arch of the first cervical vertebra (atlas) (C1L Fig. 1)



C1L Fig. 1: Location of the borders of the C1 articular facet.

Scores: 0. absent (<50%) 1. present (≥50%)

Absent (<50%): It is common to have a rounded to sharp, distinct, but narrow and regular, bony elevation surrounding part or all of the facet. This raised rim can sometimes take on a somewhat irregular appearance, but does not satisfy the length or extension criteria for lipping.

Present (≥50%): Irregular bony growth extends superiorly, inferiorly, or laterally ≥1.5 mm from the joint margin, bordering ≥50% of the articulation surface.

Notes:

- The bone growth around the articulation facet resembles the lipping seen at other synovial joint margins.
- The *present* category is typically easily identifiable as soon as you pick up the bone. If close inspection is required, then the trait is usually scored as *absent*.

Examples:



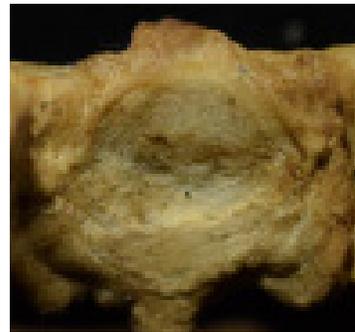
C1L-1: Absent
The articulation facet does not have distinct margins. No lipping is present. (ID#:1758)



C1L-2: Absent
Narrow raised rim that does not meet the criteria for lipping to be present. (ID#:2301)



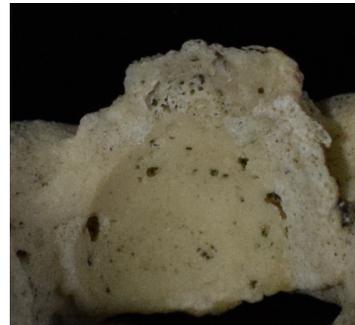
C1L-3: Absent
Small raised rim inferiorly. No lipping is present. (ID#:1491)



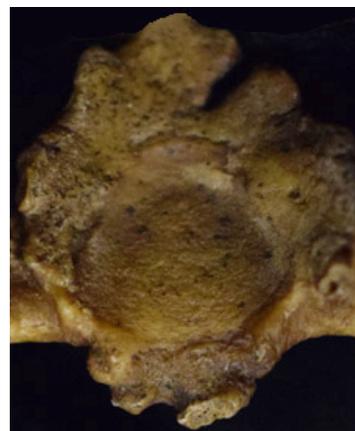
C1L-4: Present
At least 1.5mm of lipping extends outward around ≥50% of the margin of the articular facet. (ID#:1626)



C1L-5: Present
(ID#:2359)



C1L-6: Present
More than 1.5mm of lipping extends outward from around more than half of the articular facet. (ID#:1365)



C1L-7: Present
(ID#:2659)

C1 eburnation (C1 dens articulation surface eburnation)

Location: the articulation surface for the dens on the anterior arch of first cervical vertebra (C1E Fig. 1) Fig. 1)

Scores: 0. absent 1. present

Absent: No eburnation exists on either the articulation facet or the additional bone surrounding it.

Present : Eburnation is characterized an area of shiny, smooth, dense-looking bone on either the joint surface or any lipping surrounding it. A single spot of eburnation is sufficient to be scored as present.

Notes:

- C1 eburnation is the same as that often seen on the articulation surfaces of other synovial joints.
- Any bony growth around the articulation surface should be treated as an extended joint surface. If eburnation is found only on this lipping, it should still be scored as *present*.
- If the bone is covered in preservative, dirt, or grease, this feature is often not observable.
- It is possible to have eburnation without being scored as $\geq 50\%$ lipped (see C1 lipping).

Examples:



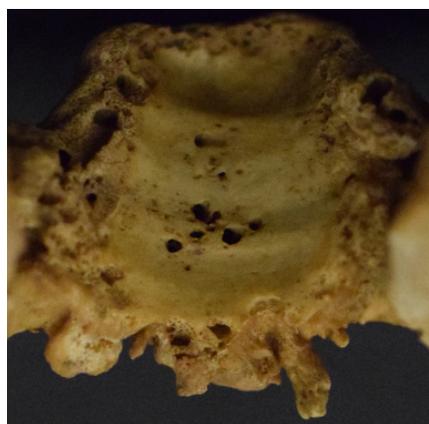
C1E-1: **Present**
Lipped with extensive eburnation on articular surface. (ID#:2022)



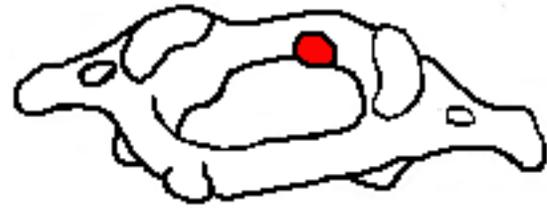
C1E-3: **Present**
Extensive eburnation on both the original articular surface and surrounding lipping. (ID#:1411)



C1E-2: **Present**
Extensive eburnation on articular surface and bordering portions of the surrounding bone growth. (ID#:1365)



C1E-4: **Present**
Extensive eburnation of articular surface and surrounding irregular lipping. (ID#:2678)



C1E Fig. 1: Location of dens articular facet.

L1 spinous process flattening

Location: dorsal end of the spinous process of the first lumbar vertebra is examined

- Scores:**
- 0. smooth (convex / round)
 - 1. smooth (flat)
 - 2. ligament ossification (any shape)

Rounded: The spinous process of L1 is smooth and round, as seen in a lateral view, with no ligament ossification.

Flat: The spinous process of L1 is smooth and flat, with no ligament ossification, when viewed laterally. The surface texture of the spinous process is typically the same as in the round category.

Ligament ossification (any shape): The process is ossified when $\geq 1\text{mm}$ of ossified ligaments are present, cranially, caudally, laterally (around the edges), or posteriorly. If ossified, the overall shape of the process is not important.

Notes:

- The change from rounded/flat to ossified results from the ossification of ligaments that eventually can bridge the spinous processes of the vertebrae.

Examples:



L1-1: Round
The spinous process is rounded and the bone is smooth. (ID#:2438)



L1-2: Round
The shape of the spinous process is slightly rounded, but smooth. (ID#:2723)



L1-3: Flat
(ID#:1731) Image reversed.



L1-4: Flat
(ID#:2724)



L1 Fig. 1: Scoring location on spinous process in lateral view.



L1-5: Ossified
More than 1mm of ossification on a rounded surface. (ID#:1701)



L1-6: Ossified
Irregular ossification on a round surface. (ID#:1378) Image reversed.



L1-7: Ossified
Ossification on a flat surface. (ID#:2679)



L1-8: Ossified
(ID#:2725)



L1-9: Ossified
(ID#:1496) Image reversed.



L1-10: Ossified
Ossified ligaments project for $\geq 1\text{mm}$ superiorly and inferior. (ID#:1472) Image reversed.

L1 & L5 epiphyseal ring fusion (superior & inferior body surfaces)

Location: superior (cranial) and inferior (caudal) surfaces of the first and fifth lumbar vertebrae (Fig. 1)

Scores: 0. not fused (NF) 1. partially fused (PF)
2. remnant line (RL) 3. fully fused (FF)

Not fused (NF): The epiphyseal ring is not fused.

Partially fused (PF): Some, but not all, of the epiphyseal ring is fused to the body. Often one or more pieces of the partially fused ring are broken off the vertebral body. If the depths of the groove between the ring and body visible on the ventral portion of the vertebral body are open, the trait is scored as partial fusion (e.g., LEF-4)

Remnant line (RL): A remnant line (RL) of any length is present when the epiphyseal ring is completely fused, but not fully integrated into the anterior surface of the body. The remnant line is a noticeable, but shallow, groove located 1-2 mm from the articular surface. The groove has rounded borders and the bottom is clearly visible (fused).

Fully fused (FF): There is no sign of epiphyseal fusion.

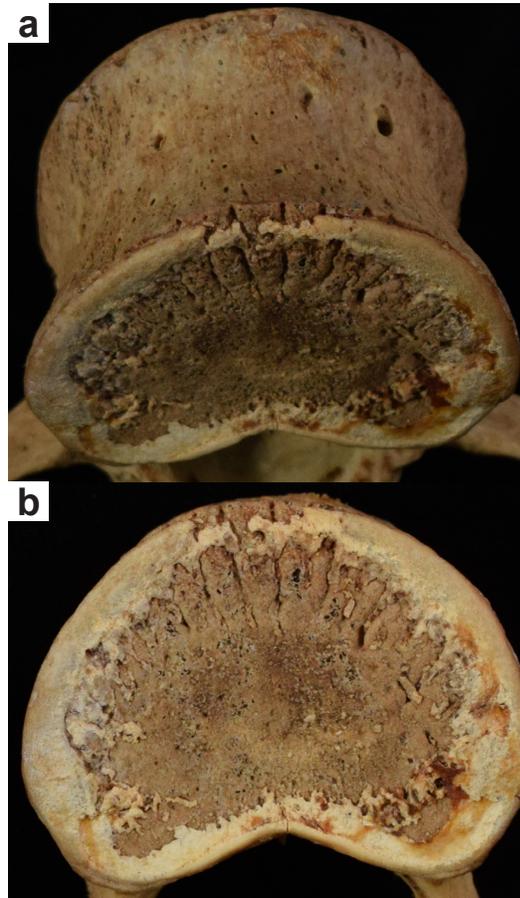
Notes:

- The superior and inferior epiphyseal rings of L1 and L5 are scored separately. They often have slightly different scores when rings are in the process of fusing.
- Remnant lines may appear anywhere along the margins of the vertebral body. Typically, the most lateral portions are the latest to fuse.

Examples:



LEF-1: Not fused
a) Superior and b) anterior views of the same L5 vertebra without epiphyseal ring fusion. (ID#:1125)



LEF-2: Partially fused
a) Inferior oblique and b) inferior views of a partially fused epiphyseal ring. Most, but not all, of the epiphyseal ring is fused. (ID#:2199)



LEF-3: Partially fused (a) & remnant line (b)
a) Inferior epiphysis is partially fused. The bottom of the groove between the epiphyseal ring and body is open, and the margins are sharp. b) The superior epiphysis is a remnant line. The bottom of the groove is easily visible, hence the ring is fully and firmly attached to the body. The margins are round. (ID#:1913) Specimen number removed from image.

L1 & L5 surface morphology (superior & inferior body surfaces)

Location: the anterior portion of the superior and inferior surfaces, 1 cm interior to the vertebral border, including the epiphyseal ring (LS Fig. 1)

- The anterior half is the portion anterior to the widest portion of the vertebral body, excluding the central portion of the face.

Scores: 0. billows (GF) 1. flat
2. porous (macro or pits)

Billows (GF): At least half (1/2) of the scoring area is covered by rounded radiating billows (low, rounded ridges), 10 mm or more of which along the anterior portion of the vertebra must be well-defined. Individual billows are 2-3 mm wide, as measured from the depths of the grooves on either side of the raised area.

Flat: The vertebral body has a flat appearance. Sometimes extremely low elevations (residual billows) without well-defined peaks and flanking valleys or narrow striations may be present; the surface is still classified as flat.

Porous: At least one-third (1/3) of the scoring area (see LS Fig. 1) is covered with either holes greater than 1 mm in diameter (macropores) or with a proliferation of micropores forming concentrated areas of pitting.

Pitting commonly occurs on the epiphyseal ring, but can occur anywhere within 10 mm of the vertebral border. A surface with a number of non-contiguous micropores is scored as flat.

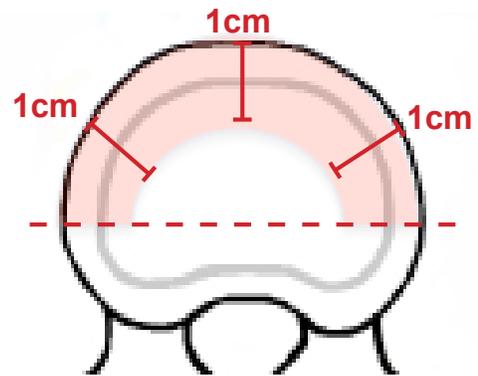
Notes:

- Schmorl's Nodes are not scored; they can render a vertebra not scorable.
- Vertebrae altered through infection, trauma, or collapse should not be scored.

Examples:



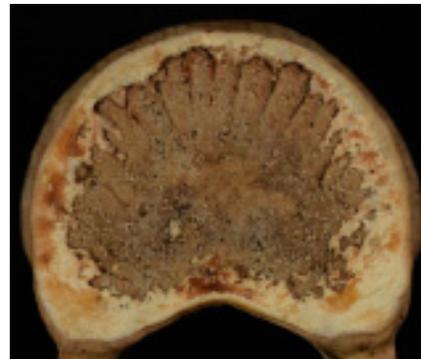
LSM-1: **Billows**
Deep billows cover the entire scoring area. (ID#:1758)



LSM Fig. 1: Surface morphology scoring area (shaded area). Shaded area indicates the region 1 cm interior to the edge of the body, including the epiphyseal ring. Dotted line indicates the part scored (anterior to the widest part of the body).



LSM-2: **Billows**
Well-defined billows cover almost all of the scoring area. Deep channels (grooves) separate the rounded hills. (ID#:1758)



LSM-3: **Billows**
Well-defined billows cover more than 1/3 of the scoring area under a fused epiphyseal ring. (ID#:2199)



LSM-4: **Billows**
Borderline case. Billows cover $\geq 1/3$ of the scoring area. At least 10 mm of those on the right side of the scoring area are well-defined with clearly visible crests and valleys. (ID#:2438)



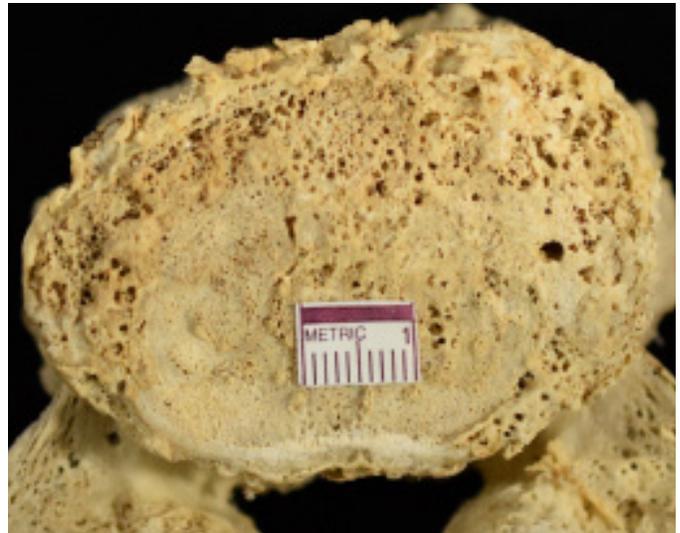
LSM-5: Flat
Flat surface with faint residual billows (left side of the scoring area) and linear exostoses. (ID#2438)



LSM-8: Porous
Microporous pitting covers $\geq 1/3$ of the scoring area. (ID#:1959)



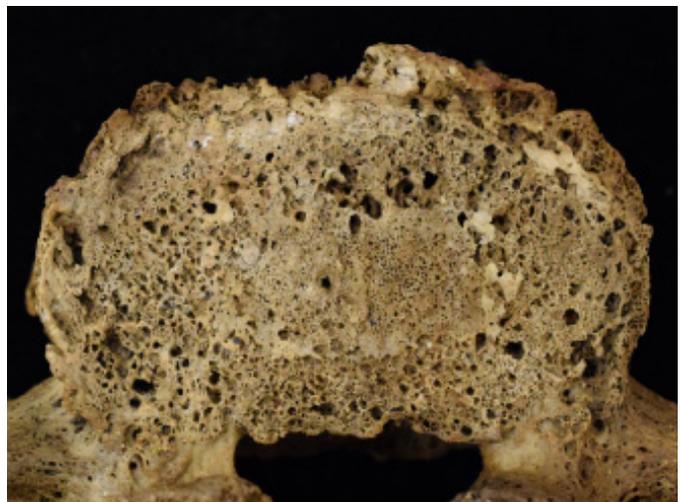
LSM-6: Flat
Flat surface with scattered microporosity. No microporous pitting (See LSM-7) or macroporosity is present. (ID#:2303)



LSM-9: Porous
Microporosity and macroporosity cover the entire scoring area. (ID#:1762)



LSM-7: Porous
Microporous pitting is present on the epiphyseal ring that covers $\geq 1/3$ of the scoring area. (ID#:1438)



LSM-10: Porous
Macroporosity covers essentially all of the scoring area. (ID#:2678)

L5 margin shape (superior & inferior body surfaces)

Location: the anterior 20 mm (10 mm either side of the midline) of the superior and inferior margins of the fifth lumbar vertebra (L5MS Fig. 1).

Scores: 0. round 1. sharp 2. lipped

Round: The ventral margin is smooth and rounded. The margin transitions without interruption from the superior or inferior surface to the anterior surface.

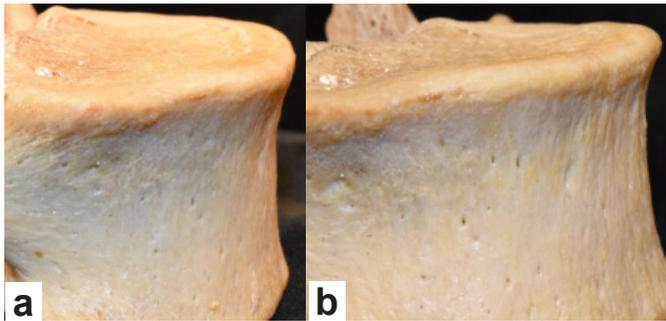
Sharp: A reasonably sharp edge (angle) is present between the articular and anterior surfaces. The edge feels sharp when rubbed against the sensitive skin on the palmar surface of the finger joints.

Lipped: The margin has any amount of bony lipping. Lipping typically occurs on an otherwise angular margin. If lipping has resulted in fusion to another vertebral element, it should be scored as lipped.

Notes:

- It is often easier to score the inferior margin by turning the vertebra over to view the margin in an inferior to superior direction.
- If the epiphyseal ring is unfused, the margin should be scored as *round*.

Examples:

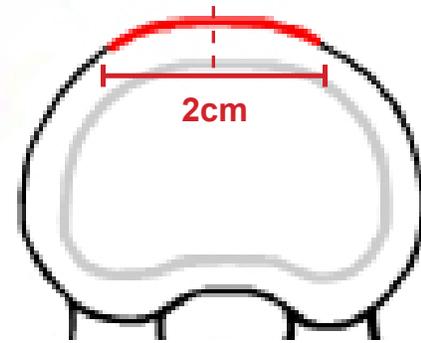


L5MS-1: Round

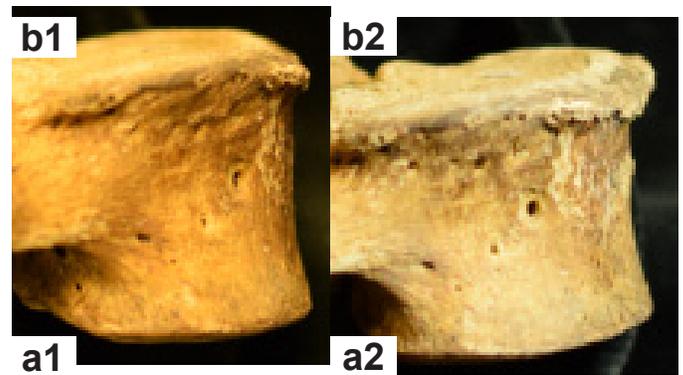
Lateral (a) and anterior-oblique (b) views of the same superior margin. The superior surface merges with the anterior face in a smooth, continuous arc. (ID#:2454)



L5MS-2: Round
Both the superior and inferior margins are round. (ID#:2182)
Image reversed.

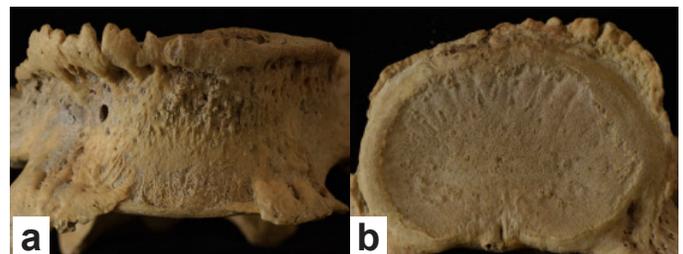


L5MS Fig. 1: Anterior 20 mm (2cm) of the vertebral margin (superior margin shown). Superior and inferior margins are scored independently.



L5MS-3: Sharp (a) & lipped (b)

Lateral (1) and anterior-oblique (2) views of a sharp inferior margin (a) and a lipped superior margin (b). Inferiorly, the anterior surface of the body meets the inferior articular surface at an angle, not a smooth curve (compare to L5MS-1). (ID#:2529)



L5MS-4: Lipped

Anterior (a) and superior (b) views of a lipped superior margin. (ID#:2726)



L5MS-5: Lipped
Superior view of lipped superior margin. (ID#:2725)

S1 margin shape (1st sacral vertebra superior anterior border)

Location: middle 20 mm of the anterior (ventral) superior edge of the first sacral body (S1)

Scores: 0. round 1. sharp 2. lipped

Round: The (ventral) margin is smooth and rounded. The margin transitions without interruption from the superior to anterior surface.

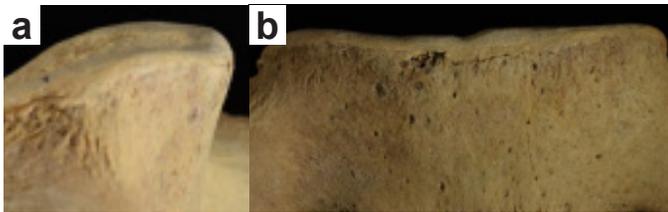
Sharp: A reasonably sharp edge (an angle) is present between the superior and anterior surfaces.

Lipped: The margin has any amount of bony lipping. Lipping is typically only found on an otherwise angular margin.

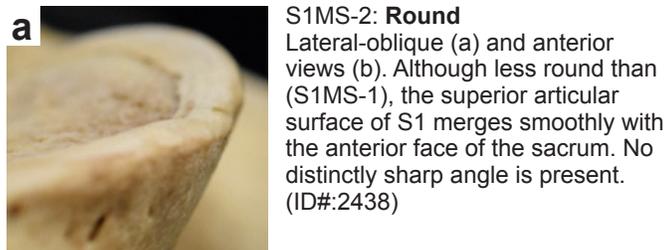
Notes:

- The difference between rounded and sharp must be adjusted for size. It is common for particularly small individuals to have a margin that feels sharper than normal, but that is still round.
- The distinction between the round and sharp categories can be felt as well as seen – the former is best done with the sensitive part of the palmar surface of a finger joint.
- The bone should be scored as lipped if fusion to the last lumbar vertebra has occurred as the result of bony lipping.

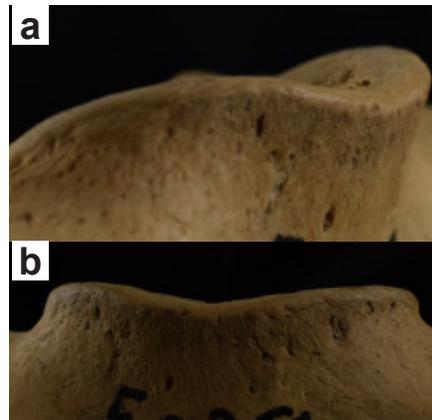
Examples:



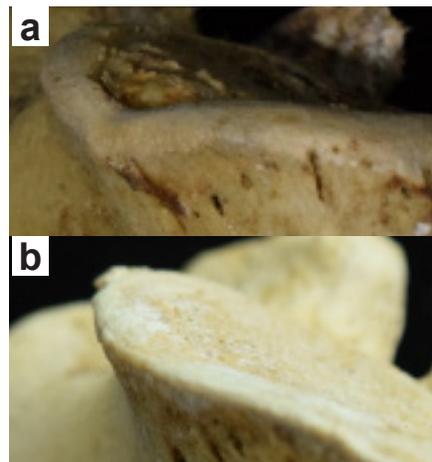
S1MS-1: Round
Lateral-oblique (a) and anterior views (b, slight postmortem damage). The superior surface of S1 meets the anterior surface in a smooth, rounded curve. (ID#:2078)



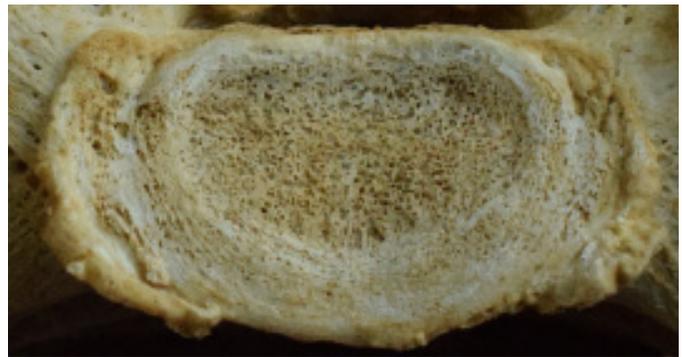
S1MS-2: Round
Lateral-oblique (a) and anterior views (b). Although less round than (S1MS-1), the superior articular surface of S1 merges smoothly with the anterior face of the sacrum. No distinctly sharp angle is present. (ID#:2438)



S1MS-3: Round
Lateral-oblique (a) and anterior views (b). Although less round than (S1MS-1), the superior articular surface of S1 merges smoothly with the anterior face of the sacrum. No distinct sharp edge (angle) is present. (ID#:2727)



S1MS-4: Round (a) & sharp (b)
Oblique views of round (a) and sharp (b) margins. In sacrum (b), the anterior margin where the superior and anterior surfaces meet is a sharp angle. This distinction can be seen and felt. [a] ID#:1070, Image reversed; b) ID#:1695]



S1MS-5: Lipped.
Superior-oblique view of a slightly lipped anterior margin, with significant lipping present lateral to the scoring area. The slight lipping occurs on an otherwise angular margin; any lipping is sufficient for a lipped score. (ID#:1477)



S1MS-6: Lipped
Anterior view of substantially lipped margin. (ID#:2040)

S1-2 fusion (1-2 sacral body fusion)

Location: the anterior surface of the sacrum where the first two sacral bodies meet

Scores: 0. gap \geq 10mm 1. gap $<$ 10mm 2. closed

Gap \geq 10mm: A gap more than 10 mm in length is open without interruption.

Gap $<$ 10mm: A gap less than 10mm long is present.

Closed: There is no evidence of a gap between the anterior sacral bodies.

Notes:

- A gap is considered present when there is an opening that extends into the space between the two sacral bodies.
- Many specimens where vertebral shifts occur cannot be recorded.

Examples:



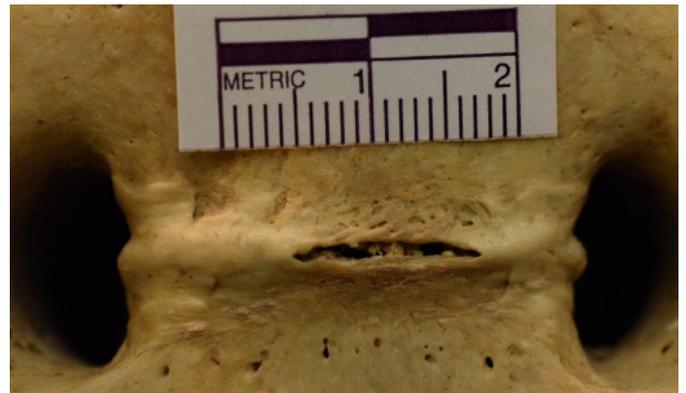
S12F-1: **Gap \geq 10mm**
The joint between S1 and S2 is completely open. (ID#:2405)



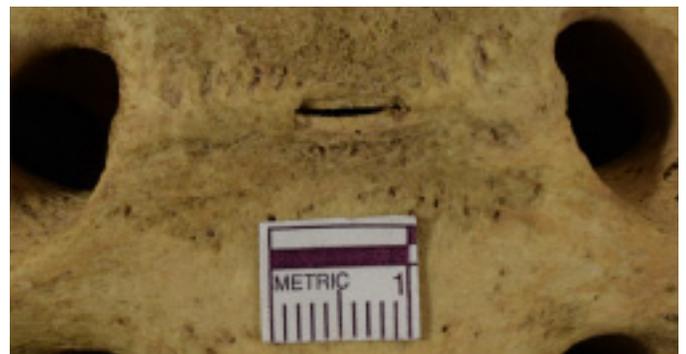
S12F-2: **Gap \geq 10mm**
The joint between S1 and S2 has started to fuse internally but is still visible along its entire length. More than 10mm of the space is open. (ID#:2464)



S12F-3: **Gap \geq 10mm**
The lateral portions of the joint have started to fuse externally, but more than 10mm of the joint is open. (ID#:1804)



S12F-4: **Gap \geq 10mm**
An opening just over 10mm in length is present. (ID#:2438)



S12F-5: **Gap $<$ 10mm**
A gap of less than 10mm is present. In some individuals, small gaps will persist for most or all of adulthood. (ID#:2163)



S12F-6: **Closed**
(ID#:2116)

Sacral “Elbow”

Location: the anterior (ventral) surface of the sacrum – the angle of interest is located between S2 and S4, including the joints between them (S2-3 & S3-4)

Scores: 0. absent 1. present

Absent: The anterior curvature of the sacrum is a relatively smooth arc. If a fracture is present, it does not create a large enough change in the sacral curvature to be considered present.

Present: The normal superior to inferior curve of the sacrum must be interrupted by a distinct break (a sharp change in angle) of approximately 90 -110° (SE-2 Fig. 1). The angle often results from a readily visible antemortem fracture somewhere on or between the second and fourth sacral segment (S2-S4). The healed fracture, with or without obvious remodeling, results in a change in the typically continuous contour of the ventral surface.

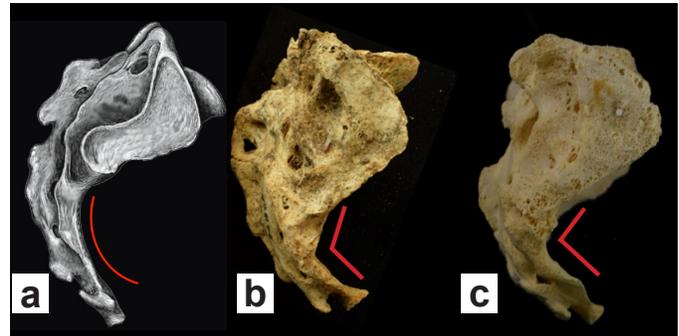
Notes:

- Both anterior and lateral views are typically necessary to evaluate a sacral “elbow.”
- Sacral fractures most often occur in osteoporotic individuals. However, lower than normal bone mineral density is not a requirement for this feature to be scored as present.
- The angle of interest most often occurs on S3, S4, or the joint between them, but can occur slightly higher or lower.

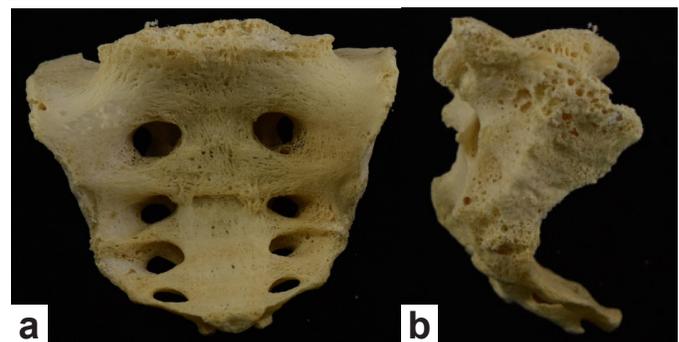
Examples:



SE-1: Absent
Normal sacral curvature. The angle of sacral curvature, when viewed laterally, of normal individuals may appear to be similar to those with an “elbow” (compare with SE-3). However, there is no break or sharp change in angle on the anterior surface of the sacrum. (ID#:2386)

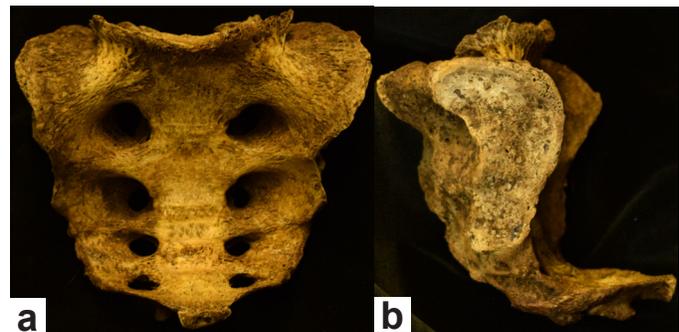


SE: Fig. 1: Lateral views of normal sacral curvature (a) and two sacral elbows (b,c). The angle created by an elbow in the sacral curvature is typically between approximately 90 -110° when viewed laterally.



SE-2: Present

Anterior (a, specimen number removed from image) and lateral (b) views. The angle in sacral curvature occurs between S2 and S3. (ID#:1791)



SE-3: Present

Anterior (a, specimen number removed from image) and lateral (b) views of a sacral elbow. The change in curvature occurs on S3. (ID#:2660)



SE-4: Present

Lateral view of sacral elbow. The change in sacral curvature occurs between S3 and S4. An abrupt change in sacral curvature is the critical feature for the trait to be scored as present. (ID#:1670) Image reversed.

Vertebral lipping

Location: the anterior portions of the superior and inferior edges of cervical vertebrae three through seven, and in all thoracic and lumbar vertebrae

Scores:

cervical: 0. absent (<3 mm) 1. present (≥3 mm)
 thoracic: 0. absent (<5 mm) 1. present (≥5 mm)
 lumbar: 0. absent (<5 mm) 1. present (≥5 mm)

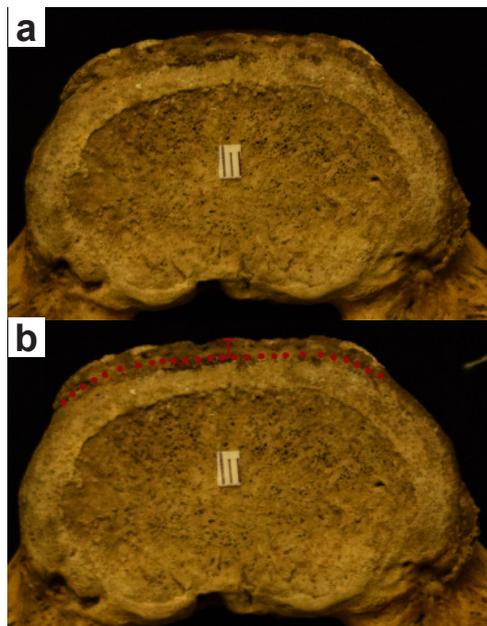
Cervical, thoracic, and lumbar vertebrae are scored separately. The number of scorable edges in each group is recorded.

Present: Lipping is present if it extends anteriorly, cranially, or caudally from the margin ≥3 mm for cervical or ≥5 mm for thoracic and lumbar vertebrae. Lipping is measured from the original vertebral margin to the furthest extent of the osteophyte (outward, upward, or downward from the vertebral body), not the distance along the margin.

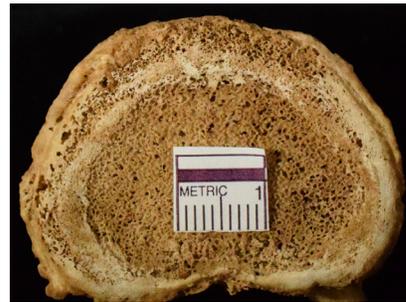
Notes:

- Vertebrae fused through lipping or candlewax should be scored as lipped (e.g., VL-6).
- Congenitally fused vertebrae, particularly common in the cervical spine, should not be scored.
- It is not unusual for vertebral margins to appear highly irregular and porous, but have an insufficient amount of lipping to be scored as present. This is particularly common for cervical vertebrae.

Examples:



VL-1: Absent
 (a) Lipping extends outward from the original edge by <5 mm. (b) The original margin of the epiphyseal ring has been estimated (dotted line) and the lipping (solid line) is measured from this estimated edge. (ID#:2529)



VL-2: Absent
 The lipping on this lumbar vertebra extends outward from the estimated original edge by <5 mm. (ID#:1438)



VL-3: Lipped (≥5 mm)
 Superior view of lumbar vertebra. (ID#:2141) Specimen number removed from image.



VL-4: Lipped (≥3 mm)
 Inferior view of a cervical vertebra with lipping that extends ≥3 mm. Scoring thresholds were selected to be easily evaluated by eye in most cases, although verification with a ruler is recommended. (ID#:2649)



VL-5: Lipped (≥5 mm)
 Thoracic lipping that is also candlewax. (ID#:2689)



VL-6: Lipped (≥3 mm)
 Fusion of two cervical vertebrae through candlewax. Fusion in this manner is sufficient to be scored as lipped; however, the inferior border of the lower of the two fused vertebrae has sufficient lipping to be independently scored as lipped. (ID#:2629)

Vertebral candlewax

Location: superior edges, inferior edges and anterior surfaces of the vertebral bodies of cervical three through seven, and all thoracic and lumbar vertebra

Scores: 0. absent 1. present

Cervical, thoracic, and lumbar vertebrae are scored separately. The number of scorable edges is recorded.

Present: Candlewax is a distinctive form of bony growth typically associated with advanced osteoarthritis and Diffuse Idiopathic Skeletal Hyperostosis (DISH). The hard and smooth (sclerotic) bone looks like hardened candlewax that has flowed down the vertebral bodies and across the joints between vertebrae. Candlewax expands at the joints of vertebrae, creating swellings in the bony flow. If candlewax is visible on one or more of the vertebral edges, then the trait is scored as present.

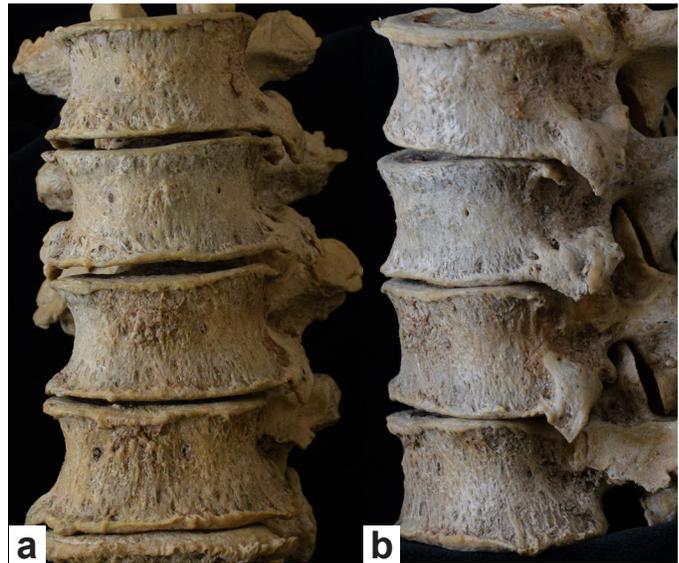
Notes:

- Fusion of vertebral elements is not necessary for candlewax to be present (e.g., CW-1, CW-2)
- As compared to osteophytes, which originate from the margins of the vertebrae, the smooth, shiny sclerotic bone characteristic of candlewax is typically present on the anterior surfaces of the vertebrae, as well as flowing over and across the joint margins.

Examples:



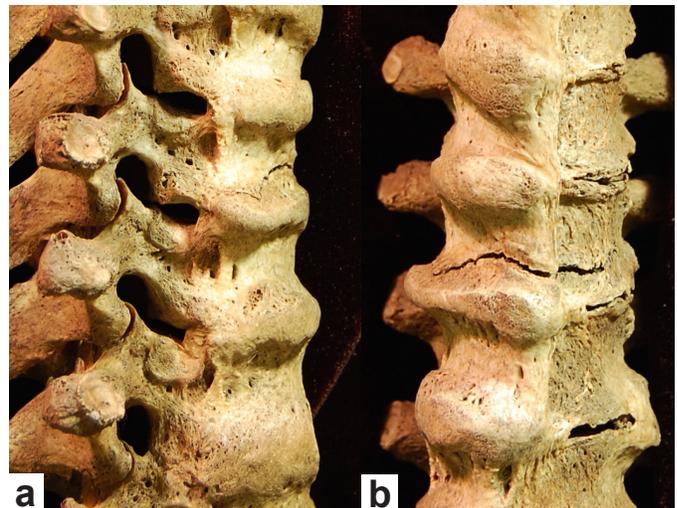
CW-1: Present
Minor, unfused candlewax. The candlewax originates on the body of the vertebrae, spans the joint space, and has a different texture than the surrounding bone. (ID#:1978)



CW-2: Present
Anterior (a) and lateral-oblique (b) views of unfused candlewax present only on the left inferior edges. The candlewax originates on the body of the vertebra, spans the joint space, and has a sclerotic appearance. (ID#:2016)



CW-3: Present
Candlewax of adjacent vertebrae spans the joint space and forms touching facets, but is not fused. It is different in both color and texture than the surrounding bone. (ID#:2689)



CW-4: Present
Lateral (a) and anterior (b) views of candlewax-fused vertebrae. (ID#:2615)

Vertebral DISH

Location: superior edges, inferior edges and anterior surfaces of vertebral bodies (C3-L5)

Scores: 0. absent (< 4 vertebrae)
1. present (≥ 4 vertebrae)

Absent: Candlewax is absent or does not span three or more joints.

Present: Candlewax is hard and smooth surfaced (sclerotic) bone that looks like wax flowing down and across the joints between vertebrae. Usually the candlewax expands at the joints of vertebrae where it spans the normal joint space, which results in swellings in the bony flow.

If candlewax is present on four or more adjacent vertebrae (crossing three or more joints) in the same orientation (on the same side of the vertebrae), then DISH is scored as present. When present, the type of vertebrae fused should be noted (C – Cervical; T – Thoracic; L – Lumbar).

Notes:

- If four or more vertebrae are not present (e.g., only two bones are present), the presence of DISH cannot be scored.

Examples:



DISH-1: **Present**
Unfused candlewax is present and spans more than three contiguous joints (four vertebrae). (ID#:2689)



DISH-2: **Present**
Anterior (a) and lateral (b) views of fused candlewax that spans more than three contiguous joints (four vertebrae) on the same side. DISH in the thoracic spine most commonly occurs on the right side, but can occur anywhere on the vertebral bodies (see DISH-3). (ID#:2615)



DISH-3: **Present**
Candlewax is present on both the anterior and right lateral surfaces of more than four vertebrae. (ID#:1876)

STERNUM & RIBS

R1 fusion (1st rib – manubrium fusion) [bilateral]

Location: the manubrium, first rib, and costal space between them

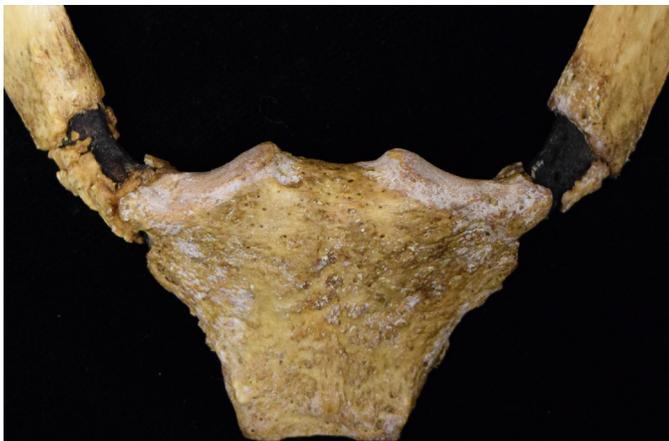
Scores: 0. absent 1. fused

Fused: The first rib is connected to the manubrium by at least one bony bridge on either or both sides.

Notes:

- Be sure to look carefully for bony connections between the first rib and manubrium that may have been broken postmortem.
- When the first costal cartilage has been preserved, look closely to determine whether the first rib has truly fused to the manubrium or is only held in place by dried or partially ossified cartilage.

Examples:



R1F-1: Absent

Anterior view. The first ribs are attached bilaterally to the manubrium by dried cartilage. Isolated ossifications are present in the space between the first rib and the manubrium, but no bony bridges connect them. (ID#:2449)



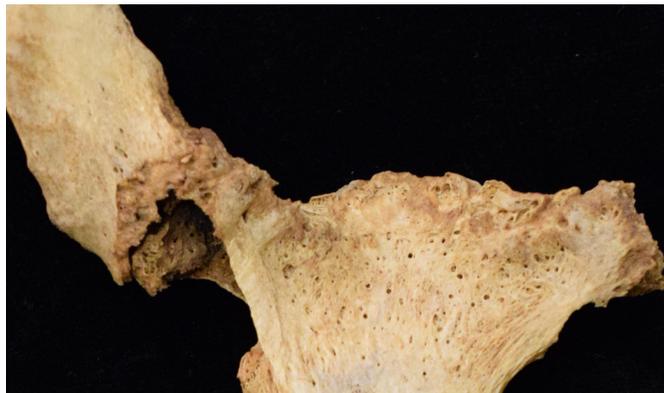
R1F-3: Present

Anterior view of unilateral right fusion. (ID#:2335)



R1F-2: Present

Anterior view of left unilateral fusion. (ID#:1808)



R1F-4: Present

Dorsal view of unilateral left fusion. (ID#:2547)

Sternum central dorsal ridge

Location: the dorsal (posterior) surface of the completely fused adult sternal body, excluding the manubrium and xiphoid process

Scores: 0. absent 1. present

Present: A single, central ridge runs superiorly to inferiorly along the midline of the dorsal sternal surface. It must be 15 mm long and 1.5 mm wide at least at one point.

The ridge is an addition of bone on the sternal surface with sharp borders. It can be seen and felt (compare SDR-2 and SDR-6).

Notes:

- A line of small, narrow, linearly oriented spicules that does not form a continuous ridge is insufficient to be scored as present.
- A central ridge can be present in isolation or with similar lines or ridges that occur on the lateral borders of the sternal body. These laterally located lines can exist unilaterally, and should not be confused with the central dorsal ridge along the midline.
- The feature cannot be scored if there has been thoracic surgery that involved cutting the sternum superiorly to inferiorly.

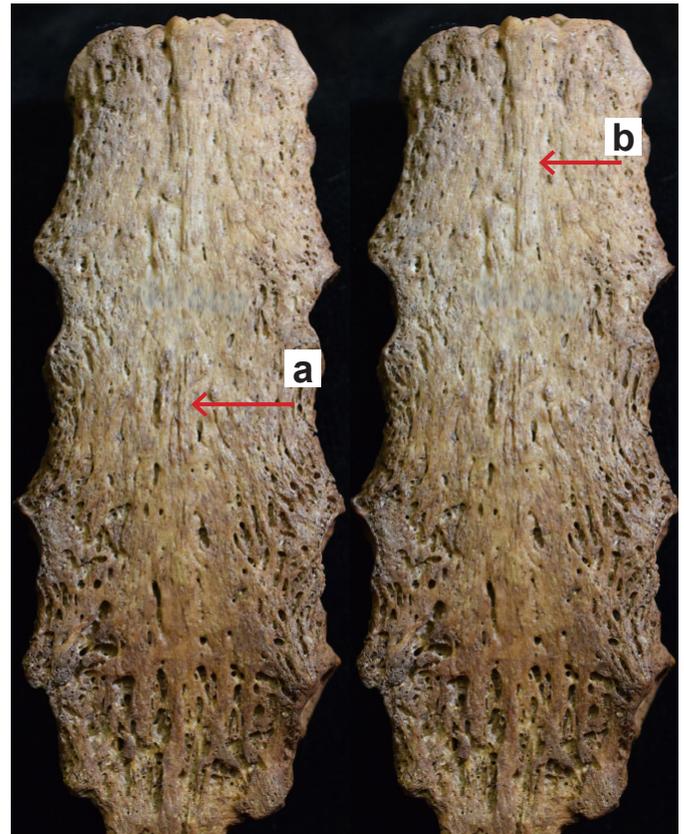
Examples:



SDR-1: Absent
No central ridge is present. Poorly expressed lateral ridges are present inferiorly, but only ridges located in the center of the dorsal sternum are scored. (ID#:2303)

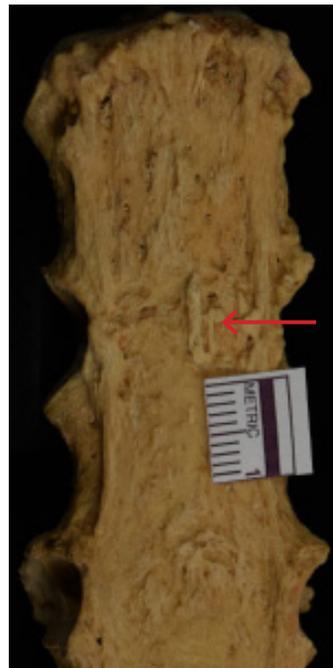


SDR-2: Absent
This is a slightly rounded, raised mound along the midline, but no substantial addition of bone. Compare to SDR-10. (ID#:1808) Specimen number removed from image.



SDR-3: Absent

(a) Borderline case. A central line of narrow, linear spicules is present that are not 1.5 mm wide. (b) It is common to have a raised area with rounded borders 10 to 20 mm long in the superior portion of the sternal body that should not be confused with a central ridge. (ID#:2486)



SDR-4: Absent
Borderline case. The central dorsal ridge is present but is not at least 15mm in long. Lateral ridges are also present, but are not scored as part of this trait. (ID#:2013)



SDR-5: Absent
A single lateral ridge is present on the left side, but no central ossification is present. (ID#:2659)



SDR-6: Present
 Posterior (a) and lateral-oblique (b) views. The central ridge is an addition of bone onto the surface that is at least 1.5 mm wide and 15 mm long with well-defined, sharp edges. (ID#:1940)



SDR-8: Present
 A central dorsal ridge is present, along with poorly defined lateral ridges. (ID#:2401)



SDR-9: Present
 A central dorsal ridge is present, along with poorly defined lateral ridges. (ID#:2435)



SDR-7: Present
 Posterior (a) and lateral-oblique (b) views of an unusually wide central dorsal ridge. (ID#:2004) Specimen numbers removed from images.



SDR-10: Present
 A short (≥ 15 mm) segment of ossification is located in the superior part of the sternal body. The well-defined edges indicate that this is a central ridge and not the raised mound that often occurs in people of all ages. Compare with SDR-3b. (ID#:2547)

R2 & R3-10 sternal end rim profiles

Location: the sternal end of rib two (R2) and ribs three through ten (R3-10), specifically the oval margin of each rib end where bone meets costal cartilage

Scores: 0. regular 1. irregular

Regular: The end of the rib is straight or scalloped, but not lipped.

Irregular: The margins of the sternal end are typically thin and even a small amount of bone growth results in an irregular appearance. In many cases, additional irregular ossifications project beyond the original borders of the rim resulting in a ragged or claw-like appearance.

Notes:

- Occasionally tube-like ossifications encircle the entire sternal end of a rib, but do not form jagged (or claw-like) protrusions. These ossifications of cartilage are also classified as irregular.

Examples:



RP-1: **Regular**
Regular rim with well-defined scallops. (ID#:1804)



RP-2: **Regular**
The edges are thick and rounded. (ID#:2464)



RP-3: **Regular**
The edges are rounded and the bone is dense with a slightly scalloped appearance. (ID#:2454)



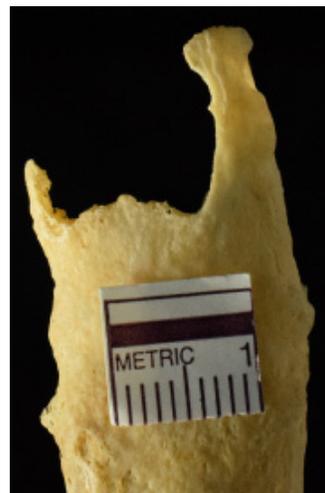
RP-4: **Irregular**
The majority of the edge is straight with slight areas of irregularity. (ID#:2303)



RP-5: **Irregular**
(#2335)



RP-6: **Irregular**
Note the preserved cartilage. (ID#:2335)



RP-7: **Irregular**
(ID#:1504)



RP-8: **Irregular**
Rib with long claw-like ossifications extending several centimeters. (ID#:1504)



RP-9: **Irregular**
Tube-like ossification. (ID#:1485)



RP-10 **Irregular**
Ossification that takes the form of a cylinder or tube. Arrow indicates the original end of the rib. (ID#:1952)

Rib ossification pattern

Location: the sternal end of rib two (R2) and ribs three through ten (R3-10), specifically the oval margin of each rib end where the bone meets costal cartilage

Scores: 0. absent 1. cone 2. claw 3. both

Claws: Claws originate from the perimeter of the sternal end and have a jagged appearance, formed by irregular ossifications ≥ 5 mm in length. Hollow, cylinder or tube-like ossifications that encircle the sternal end should be scored as claws.

Cones: Cones appear to originate from the central portion of the costal face and extend at least 5 mm or more, typically as gradually tapering, hollow bony growths.

Both: Both claws and cones are present.

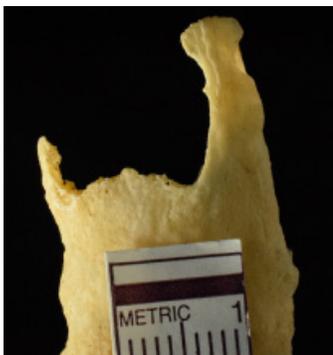
Notes:

- Occasionally tube-like ossifications encircle the entire sternal end of a rib, but do not form jagged (or claw-like) protrusions. These ossifications of cartilage are classified as irregular.
- It is possible to have a cone on a rib with a regular rim.
- Ribs with claws must, by definition, be scored as irregular.
- A single individual might have claws, cones, and both. That is, ribs with only claws, only cones, and both claws and cones.

Examples:



RO-1: Absent
Irregular rim with no claw. At least 5mm of ossification must extend beyond the original border of the rib for a claw to be present. (ID#:2303)



RO-2: Claw
(ID#:1504)



RO-3: Claw
A typical claw-like ossification. (ID#:1808)



RO-4: Claw
Cylindrical or tube-like ossification that originates from the borders of the sternal end. Arrow indicates original end of rib. (ID#:1952)



RO-5: Claw
Cylindrical ossification that originates from the borders of the sternal end, along with a more typical claw-like projection (left side). (ID#:1808)



RO-6: Claw
Partial tube-like ossification originating from the lateral margins of the rib. (ID#:2005)



RO-7: Cone
Ossification originating from the central portion of the sternal end. (ID#:1940)



RO-8: Cone
(ID#:1472)



RO-9 Both
Unusually long claw, bordering an even longer, tapering cone. (ID#:2327)

R2 & R3-10 shingle ribs (rib body thickness)

Location: the ventral third of the second rib (R2) and ribs three through ten (R3-10)

Scores: 0. normal 1. shingle

The number of scorable rib bodies (i.e., those with at least the anterior one-third intact) should be recorded.

Normal: The bone has a thick and robust appearance. The cross sections of ribs form an elongated oval with a rounded superior border and, typically, a sharp inferior border adjacent to the costal groove.

Shingle: Shingle ribs are quite narrow in cross section, and taper to a sharp margin both superiorly and inferiorly. The cortices are thin, especially noticeable in broken bones, and trabeculae are sparse. In cross section, the exterior and interior sides of the ribs parallel to one another, instead of the usual oval shape found in most adults. If present, the flattening generally occurs in the most distal (costal) thirds of the ribs, but can extend to as much as the distal two-thirds of the rib body.

Notes:

- The overwhelming majority of individuals have normal ribs. Shingle ribs are only present in clear-cut cases of thinning.
- Shingle ribs are defined by their overall cross-sectional shape, not cortical thickness. However, all shingle ribs have extremely thin cortices.

Examples:



SR-1: Normal (a) and shingle (b)
Inferior-oblique (a1,b1) and inferior (a2,b2) views of an (a) normal and (b) shingle rib.(a:ID#:2602, b: ID#:2509, image reversed.)



SR-2: Normal (a) and shingle (b)
Comparison of a normal rib and a shingle rib. The sides of the shingle rib are flat and parallel to one another. (a: unknown, b: ID#:1668)



SR-3: Normal (a) and shingle (b)
It is not uncommon for an individual to both normal (a) and shingle ribs (b). (ID#:2678)



SR-4: Shingle
Both edges of the rib are extremely sharp (superior edge can be seen in the photograph). The distal third of the rib body is thin and flat (b), while the rest retains a more normal contour (a). (ID#:2678)

UPPER LIMB

Clavicle medial epiphysis fusion [bilateral]

Location: edges and surface of the medial end of the clavicle

Scores: 0. not fused (NF) 1. partially fused (PF)
2. remnant line (RL) 3. fully fused (FF)

Not fused (NF): A ridged surface where there is no evidence of a fusing epiphysis.

Partially fused (PF): A low, smooth epiphysis covers part of the original ridged surface. It can be centrally or peripherally located. There is a distinct space between the edge of the fusing epiphysis and the original bone surface.

Remnant line (RL): There is a narrow and shallow groove where the epiphysis joins the rest of the bone. The line is a shallow, groove at least 5 mm long with a fused bottom.

Fully fused (FF): There is no evidence of where the epiphysis fused to the bone.

Notes:

- When the medial clavicle exhibits a deep conical divot, which can be unilateral or bilateral, epiphyseal fusion is not scored.
- When a shallow or partial divot is present, the medial epiphysis can be scored, but a note should be made regarding the presence of the feature.

Examples:



CEF-1: **Not fused**
(ID#:2464)



CEF-2: **Not fused**
(ID#:2405)



CEF-3: **Partially fused**
(ID#:1841)



CEF-4: **Partially fused**
(ID#:1143)



CEF-5: **Partially fused**
(ID#:1780)



CEF-6: **Partially fused**
(ID#:2015) Image reversed.



CEF-7: **Remnant line**
(ID#:2246)



CEF-8: **Remnant line**
(ID#:2268)



CEF-9: **Not scorable**
Medial (a) and oblique (b) views of a deep conical divot. The clavicle should not be scored when this feature is present.
(ID#:2476)

Clavicle medial epiphysis gravel

Location: surface of the medical end of the clavicle

Scores: 0. absent 1. present

Absent: The surface of the medial clavicle is smooth, with or without microporosity, or the irregular bone growth does not cover 5 mm or more of the surface. IF the epiphysis is not present (not fused or partially fused), then the trait is scored as absent (e.g., CMEG-1).

Present: A layer of irregular bone that is ≥ 5 mm in its longest dimension is present on top of the original clavicular surface. In many cases, the texture resembles a gravel road's surface.

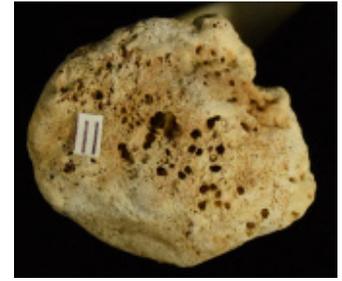
Notes:

- A shallow divot can change the texture of the medial epiphysis (see CMEG-3). Gravel typically exists on a roughened surface.
- The feature cannot be scored when a deep conical divot is present (e.g., CMEG-11).

Examples:



CMEG-4: **Present**
(ID#:1924)



CMEG-5: **Present**
Both macroporosity and an irregular addition of bone longer than 5mm in length are present. (ID#:1526)



CMEG-6: **Present**
(ID#:1485)



CMEG-7: **Present**
(#1472)



CMEG-1: **Absent**
The bumpy, but regular, unfused epiphyseal surface should not be confused with the irregular gravel. (ID#:2405)



CMEG-2: **Absent**
The epiphysis is only partially fused, so gravel is absent. (ID#:1841)



CMEG-8: **Present**
(ID#:2564)



CMEG-9: **Present**
(ID#:2133)



CMEG-3: **Absent**
Left and right clavicles with a common shape variant (shallow conical divot) that often results in a corrugated texture. This texture is regular and the bone is smooth. It should not be mistaken for irregular bone growth added to the surface that is classified as "gravel". (ID#:1445)



CMEG-10: **Present**
(ID#:2416)



CMEG-11: **Not scorable**
When a deep conical divot is present, the feature cannot be scored. (ID#:2476)

Clavicle medial macroporosity [bilateral]

Location: surface of the medical end of the clavicle

Scores: 0. absent 1. macroposity (≥ 3)
 2. macroposity ($\geq 75\%$)

Absent: The medial end is smooth, has only microporosity, or has fewer than three macropores.

It is also scored as absent when the epiphysis is not fused or partially fused (e.g., CMEM-1 & CMEM-2).

Macroporosity: The surface has 3 or more pores that are 1 mm or larger. The feature should be scored as many when more than 75% of the medial surface is macroporous.

Notes:

- Macropores in the central part of a clavicle with a shallow or deep conical divot are not scored (e.g., CMEM-6).
- Macropores can occur on the original surface of the bone or in (or around) areas of lumpy, irregular bone deposited on its surface. If present, the pores should be scored regardless of other textural changes.
- Developmental defects resembling macropores can occur on the medial clavicular surface. These defects have rounded margins and smooth walls with fused bottoms that do not expose the underlying trabecular bone (see CMEM-3). These defects are similar to those sometimes found on other articulation surfaces, such as the iliac auricular surface.



CMEM-3: **Absent**
 Several surface defects are present in the central portion of a shallow conical divot. As opposed to true macropores, these defects occur on a dense surface and have rounded borders. (ID#:2581)



CMEM-4: **Present**
 (ID#:1526)

Examples:



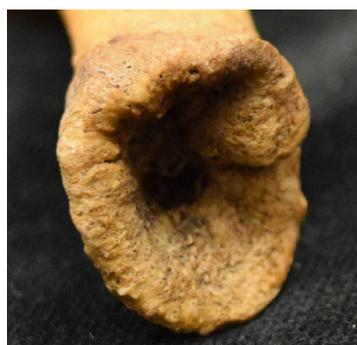
CMEM-1: **Absent**
 The epiphysis is unfused, so porosity is absent. (ID#:2405)



CMEM-5: **Present**
 Macroporosity is present within irregular bone growth. This is scored in the same way as macropores that occur directly on the subchondral surface (e.g., CMEM-4). (ID#:2133)



CMEM-2: **Absent**
 The epiphysis is only partially fused, so porosity is absent. (ID#:1841)



CMEM-6: **Not scorable**
 When a deep conical divot is present, the feature typically cannot be scored. If the entire surface is visible, any macroporosity in the depths of the divot is not scored. (ID#:2476)

Clavicle lateral macroporosity (acromial articulation) [bilateral]

Location: the lateral articulation surface where the clavicle meets the acromion process of the scapula

Scores: 0. absent 1. macroporosity (≥ 3 holes)

Absent: The articular surface is smooth, has only microporosity, or has fewer than three large pores.

Macroporosity: The articulation surface has 3 or more pores that are 1 mm or larger.

Notes:

- Macropores must be on the normally smooth articulation surface to be scored. Macropores only on the edge of the bone should not be scored.

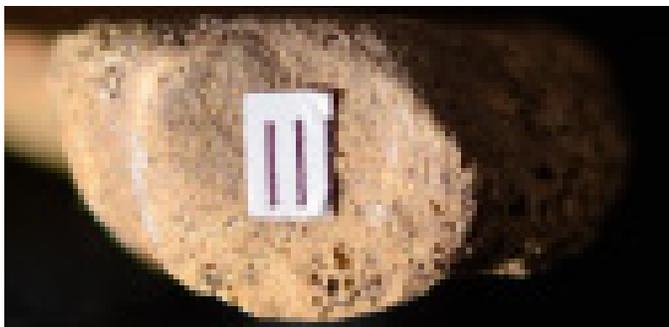
Examples:



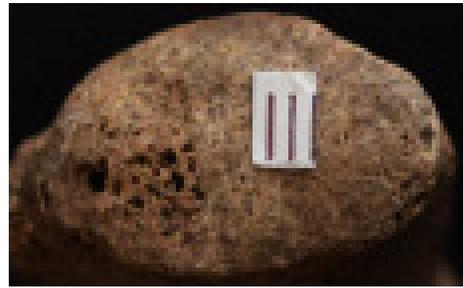
CLM-1:
Absent
(ID#:1143)



CLM-2: **Absent**
The surface has some microporosity, but no macropores are present. (ID#:1445)



CLM-3: **Absent**
Several large micropores are present, but are insufficient to qualify as macropores. (ID#:2728)



CLM-4: **Absent**
(ID#:2729)



CLM-5: **Present**
Macropores are present within additional irregular bony growth. (ID#:2133)



CLM-6: **Present**
(ID#:2303)



CLM-7: **Present**
(ID#:2730)

Scapula glenoid fossa lipping [bilateral]

Location: the margins of the articulation surface of the glenoid fossa

Scores: 0. absent 1. present (<1/2)
2. present (≥1/2)

Absent: The entire glenoid fossa has smooth rounded edges that flow without interruption from the articular surface to the external surface of the joint and beyond.

Present: Lipping refers to irregular bony growths much like what occurs at the margins of other synovial joints. The lipping can either extend laterally [towards the humerus] or perpendicularly outwards from the joint. Lipping is almost always easy to see, but early lipping may take the form of a narrow, but sharp and elevated rim.

In the <1/2 category, some sharp elevation or irregular bony lipping is present but covers less than one-half of the circumference of glenoid fossa. In the ≥1/2 category, a sharp, elevated margin or bony lipping is present around at least one-half of the circumference of the margin.

Examples:



SGFL-1: Absent
The epiphyses are unfused, thus no lipping can be present. (ID#:1125)



SGFL-2: Absent
The borders of the entire glenoid fossa are rounded. No raised edges or lipping are present. (ID#:1780)



SGFL-3: Absent
The borders of the entire glenoid fossa are smooth and rounded. The posterior border is becoming slightly sharp, but no raised edge or lipping is present. (ID#:1143)



SGFL-4: Absent
Part of the edge is slightly raised, but not lipping is present. (ID#:2464)



SGFL-5: Present (<1/2)
(ID#:1860)



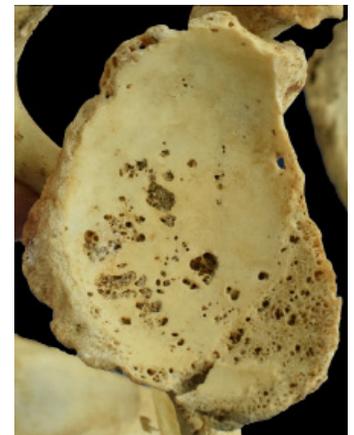
SGFL-6: Present (≥1/2)
Minor lipping is present around the entire glenoid fossa. (ID#:2659)



SGFL-7: Present (≥1/2)
(ID#:2056)



SGFL-8: Present (≥1/2)
Lipping is present around almost all of the glenoid fossa. (ID#:1411)



SGFL-9: Present (≥1/2)
The entire glenoid fossa is eburnated and expanded with irregular lipping. (ID#:1472)

Humerus weight (subjective)

Location: the entire humerus

Scores: 0. normal 1. light

Normal: The weight of the humerus falls within what is expected for an individual of that size. Bones that are borderline, or only slightly lighter than normal, should be scored as normal. This observation is subjective, so err on the side of classifying the bone as normal.

Light: The bone must be noticeably lighter than expected, but otherwise normal in appearance. A light humerus typically feels like an extremely light, hollow, cortical bone shell.

Notes:

- This trait should be recorded or, at least, mentally noted when the bones are first picked up, usually as the box is being unpacked. Handling bones for some time before scoring can result in skewed perceptions of relative bone weight.
- In rare cases bone weight is asymmetric. When this occurs, record both sides, and make a note on the data form.

Humerus weight (metric)

A rough approximation of bone “density” should also be obtained metrically whenever the bone is complete based on:

- maximum length measured using a standard osteometric board and rounded to the nearest whole millimeter
- weight measured using a digital scale and recorded to the nearest whole gram.

Humerus lesser tubercle bumps (anterior surface) [bilateral]

Location: anterior surface of the lesser tubercle of the humerus

Scores: 0. absent 1. present ($\geq 1/3$)

Absent: The anterior surface of the lesser tubercle is smooth, or $< 1/3$ of its surface is covered in bumps.

Present: Bumps range from low, rounded elevations just above the surface of the bone to large, irregular exostoses of several millimeters or more. Bumps must cover $\geq 1/3$ of the anterior surface of the tubercle to be present.

Notes:

- Irregular pitting sometimes covers part or all of the anterior surface of the lesser tubercle. If the face is entirely covered in pitting, this feature cannot be scored. If some pitting is present, it should be ignored, and the bone is scored based on the criteria described above.
- This trait cannot be scored when eburnation and lipping of the humeral head has obliterated much or all of the lesser tubercle.

Examples:



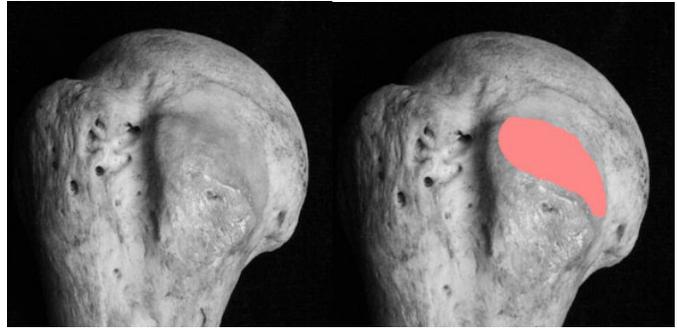
HLTS-1: Absent
The anterior surface of the lesser tubercle is slightly granular near the margin, but the bone surface is completely smooth. (ID#:1143) Image reversed.



HLTS-2: Absent
The anterior surface of the lesser tubercle is completely smooth. (ID#:2438)



HLTS-3: Absent
The anterior surface of the tubercle has several linear elevations, but no irregular bone growth (bumps) are present that appear as if they sit on top of the surface. (ID#:2359)



HLTS Fig 1. Location of the anterior surface of the lesser tubercle of the humerus.



HLTS-4: Present
Just over one-third of the surface is covered by exostoses. The pits are ignored. (ID#:2328) Image reversed.



HLTS-5: Present
Borderline case. The pits are ignored and irregular bone covers approx. one-third of the surface area. (ID#:2659) Image reversed.



HLTS-6: Present
Anterior views of the right and left lesser tubercles. The large pit on the superior portion of the right tubercle is ignored for scoring purposes. (ID#:2604)



HLTS-7: Present
(ID#:1507)



HLTS-8: Present
Almost the entire surface of the tubercle is covered by rough, irregular, bony growth. (ID#: 2547)

Humerus lesser tubercle margin shape [bilateral]

Location: lateral margin of the lesser tubercle of the humerus

Scores: 0. round/flat 1. raised 2. lipped

Round: The lateral margin and anterior surface of the tubercle are smooth and blend seamlessly together. The lateral margin of the lesser tubercle is rounded or flat, but not elevated above the tubercle's anterior surface.

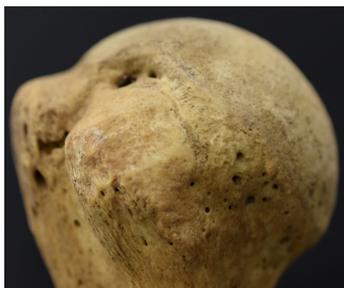
Raised: At least half of the margin of the tubercle is raised above the anterior surface of the lesser tubercle, and this elevation can be seen as well as felt. The raised area can be either smooth or rough, but it clearly rises above the anterior surface of the tubercle.

Lipped: The margin of the tubercle is noticeably roughened with irregular bony growth extending above the rounded or shape tubercle margin. The margin is irregular and distinct from the tubercle's anterior face.

Examples:



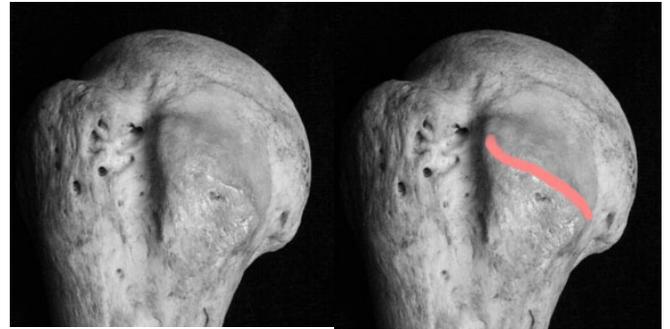
HLTM-1: **Round**
The margin of the lesser tubercle is smooth and rounded. (ID#:1143) Image reversed.



HLTM-2: **Round**
The margin of the tubercle blends seamlessly into the anterior surface of the tubercle. (ID#:2359)



HLTM-3: **Round** The margin of the tubercle is slightly more defined than in HMTM-1, but it is not raised above the anterior surface of the tubercle. (ID#:2438)



HLTM Fig 1. Location of the humerus lesser tubercle lateral margin.



HLTM-4: **Raised**
The margin is raised, but no irregular bony growth is present. (ID#:1470) Image reversed.



HLTM-5: **Lipped**
The margin is irregular. (ID#:1427)



HLTM-6: **Lipped**
The margin is covered in irregular bony growth, and the surface is covered in bumps. The margin and the surface are scored separately. (ID#:1507)

Humerus greater tubercle pits [bilateral]

Location: superior surface of the greater tubercle of the humerus

Scores: 0. absent 1. present (≥ 2)

Absent: No pits are present, or they occur only on the edges of the tubercle.

Present: Two or more macropores or deep pits occur on the proximal (superior) surface of the greater tubercle. Pits that occur only on the borders of the greater tubercle, including the superior edge closest to the humeral head, are not scored.

Notes:

- This trait cannot be scored when lipping of the humeral head completely obscures the greater tubercle.
- For this feature, only record pitting. A raised, irregular deposit of bone lacking pits is scored as absent.

Examples:



HGT-1: **Absent**
No macropores or pits are present.
(ID#:1143)



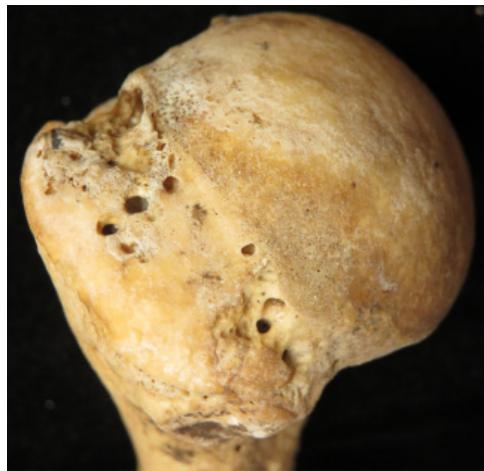
HGT-2: **Absent**
No macropores or pits are present.
(ID#:2438)



HGT-3:
Absent
Pits are only present on the medial edge of the tubercle. Image reversed.
(ID#:2034)



HGT-4:
Absent
Pits are present only on the medial edge of the tubercle.
(ID#:2731)



HGT-5:
Present
(ID#:2328)



HGT-6:
Present
Image reversed.
(ID#:2659)

Humerus medial epicondyle [bilateral]

Location: anterior surface and posterior edge of the medial epicondyle of the humerus

- Scores:** 0. smooth
1. rough ($\geq 1/2$ exostoses or 5 mm rim)

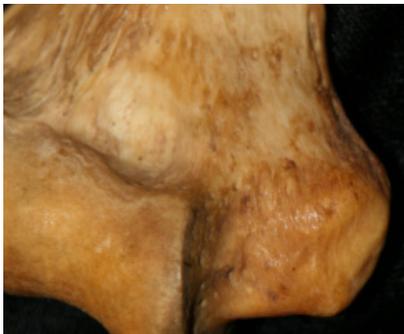
Smooth: The surface and posterior border of this area is mostly smooth, without 5 mm of posterior rim or exostoses that cover $\geq 1/2$ of the surface.

Rough: Numerous small and flat exostoses produce a markedly rough surface that covers $\geq 1/2$ of the epicondyle's anterior-medial surface or a rim at least 5 mm long is present on the posterior edge. Sometimes both exostoses and a rim are present, although the presence of one of the two features is sufficient for this feature to be considered rough.

Notes:

- The rim has to be noticeably irregular lipping as if bone has been added to the edge of the epicondyle. A low, smooth raised border can occur, but it is classified as smooth.

Examples:



HME-1: **Smooth**
Anterior view of left medial epicondyle with a smooth anterior surface and no posterior rim. (ID#:2438) Image reversed.



HME-2: **Smooth**
Anterior (a) and medial-oblique (b) views of the right medial epicondyle with a smooth anterior surface (a) and no posterior rim (b). In (b) a raised edge can be seen, but it is smooth, not irregular and rough. No lipping is present. (ID#:2005)



HME-3: **Rough**
Both a rim and exostoses are present. (ID#:2730) Image reversed.



HME-4: **Rough**
Both a rim and exostoses are present. Either feature is sufficient for the medial epicondyle to be scored as rough. (ID#:2604) Image reversed.



HME-5: **Rough**
Both a posterior rim and exostoses are present. (ID#:2328) Image reversed.

Humerus lateral epicondyle [bilateral]

Location: anterior surface and posterior edge of the lateral epicondyle of the humerus

Scores: 0. smooth
1. rough ($\geq 1/2$ exostoses or 10 mm rim)

Smooth: The surface and posterior border of this area is mostly smooth, without 5 mm of posterior rim or exostoses that cover $\geq 1/2$ of the surface.

Rough: Numerous small and flat exostoses produce a markedly rough surface that covers $\geq 1/2$ of the epicondyle's anterior-medial surface or a rim ≥ 10 mm long is present on the posterior edge. In some cases, both exostoses and a rim are present, although the presence of one of the two features is sufficient for this feature to be classified as rough.

Notes:

- The exostoses and rim of the lateral epicondyle are often larger and more pronounced than those on the medial epicondyle.

Examples:



HLE-1: Smooth
A raised edge is present on the posterior border, but no irregular lipping that would be classified as a rim. The surface is smooth. (ID#:2438)



HLE-2: Smooth
A raised rim of sufficient length is present on the posterior border, but it does not meet the height requirement necessary to be classified as present. The surface is smooth. (#1620)



HLE-3: Rough
Both a posterior rim and exostoses are present. (ID#:2328)



L **HLE-4: Rough**
The right and left epicondyles look significantly different, but both have a posterior rim and exostoses present. (ID#:2604)



R

Radius tuberosity medial crest [bilateral]

Location: medial aspect of the radial tuberosity where the tendon of biceps brachii inserts

Scores: 0. absent
1. present (≥ 1 mm high and 10 mm long)

Absent: The medial edge of the tubercle is rounded, sharp, or only slightly lipped (< 1 mm high) or the lipping extends for < 10 mm in length.

Present: A distinctive, narrow, and high crest of bone is present where the tendon inserts. This bony growth extends above the tuberosity surface by ≥ 1 mm for ≥ 10 mm in a proximal to distal direction. This ridge can have the appearance of a wave with its crest inclined over the normally smooth part of the tubercle where a bursa is located in life.

Examples:



RTMC-1: Absent
L: The rounded and smooth edge of the tuberosity is not lipped. R: Slight lipping is present, but it does not extend above the tuberosity for ≥ 1 mm. (ID#:2016)



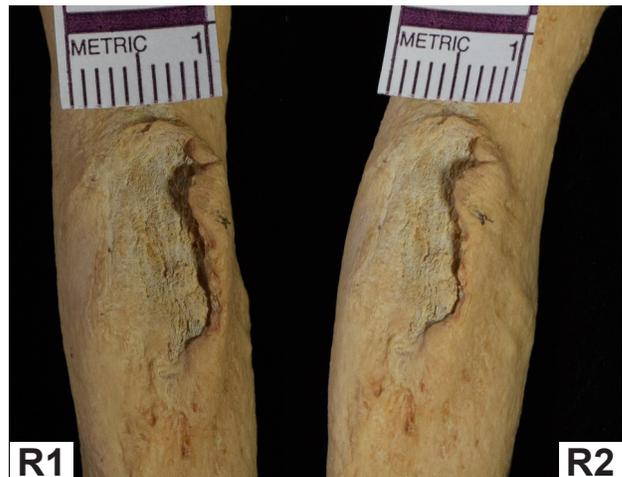
RTMC-2: Absent
Both tuberosities are slightly raised and roughened, but the lipping has insufficient height to be scored as present. (ID#:2048)



RTMC-3: Absent
Borderline case. Irregular lipping ≥ 10 mm long is present, but does not extend off of the surface for ≥ 1 mm. (ID#1823)



RTMC-4: Present
A borderline case, but just enough lipping is present (≥ 1 mm high by 10 mm long). (ID#:2460)



RTMC-5: Present
Anterior (R1) and oblique (R2) views of the same right radius. The medial tuberosity has the distinctive wave-shaped crest. (ID#:1823)



RTMC-6: Present
Bilateral wave-shaped crests. (ID#:2056)

Ulna olecranon spur [bilateral]

Location: posterior-proximal margin of the olecranon process where the triceps tendon inserts

Scores: 0. absent 1. present (≥ 2 mm)

Absent: The posterior superior edge is smooth or, if a bony growth is present, it fails to reach the 2 mm threshold.

Present: A bony spur, or occasionally spurs, project ≥ 2 mm proximally from the posterior margin of the olecranon process. When multiple projections are present their bases often merge into one large spur, giving the bone a jagged appearance.

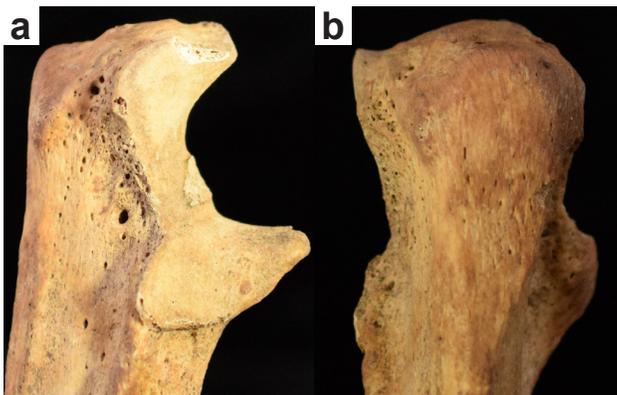
Notes:

- Spurs should be measured from the point where the spur projects from the proximal surface of the bone.

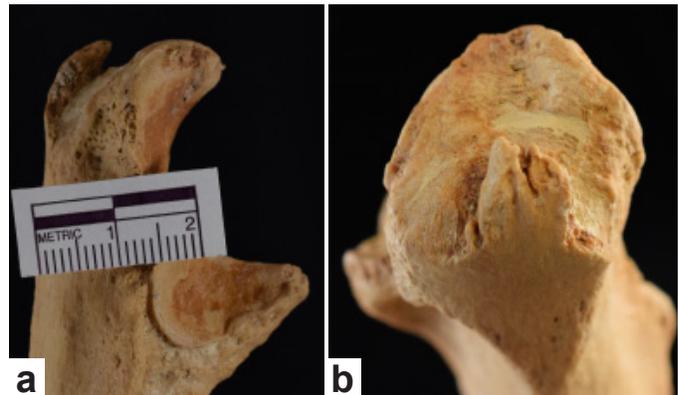
Examples:



UEPS-3 **Absent**
Small ossification that extends proximally from the surface < 2 mm. (ID#:2013)



UEP-1 **Absent**
Lateral (a, image reversed) and posterior (b) views. No ossification present. (ID#:2732)



UEP-4 **Present**
Lateral (a) and superior views. (ID#:1802)



UEP-2 **Absent**
Lateral (a) and oblique (b) views. A small amount of ossification is present, but it does not project away from the proximal surface by ≥ 2 mm. (ID#:2732)



UEP-5: **Present**
A bony spur longer than 2 mm projects superiorly from the surface of the olecranon process. (ID#:1860)

Trapezium lipping [bilateral]

Location: the circumference of the saddle-shaped articulation surface for the first metacarpal

Scores: 0. absent 1. present (≥ 2 mm)

Absent: No lipping, or < 2 mm of lipping, project outward from at least two points along the joint margin. The key feature is the absence of marked lipping. Sometimes bones marked as absent can display some eburnation, but there is little marginal lipping and the articulation surface retains its overall saddle-shaped appearance.

Present: At least 2 mm of lipping extends outward from at least two points along the margin of the saddle-shaped articulation surface. In advanced cases, the articulation surface becomes flat to irregular, lipping at the margin is extensive, and the bone no longer retains the overall shape of a trapezium (e.g., TL-6).

Notes:

- When the trapezium has fused to MC1 as a result of arthritic bony lipping (not trauma), the feature should be scored as present.

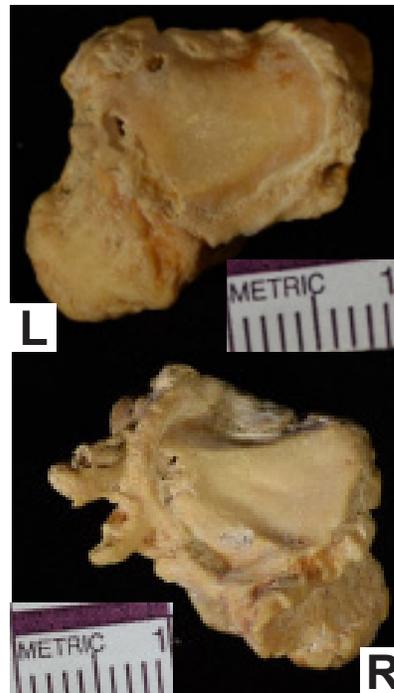
Examples:



TL-1: Absent
Only slight lipping is present around the left and right articular surfaces. (ID#:1906)



TL-2: Absent
Approximately 1 mm of extra bone growth is present around the entire articular surface. (ID#:1937)



TL-3: Present
More than 2 mm of lipping extends from at least two points on both the left and right bones. Eburnation is also present on the right side. (ID#:2237)



TL-6: Present
Bilateral lipped surfaces that also have extensive eburnation. (ID#:1919)

LOWER LIMB

Femur fovea margin lipping [bilateral]

Location: the margin of the femoral fovea where the ligamentum teres attaches (ligamentum capitis femoris)

Scores: 0. absent 1. lipped (≥ 10 mm)

Absent: The edge of the fovea is smooth or, more typically, has a rounded or sharp margin.

Lipped: Irregular bony growths extends continuously for ≥ 10 mm around the fovea margin.

This irregular lipping can be as much as 2-4 mm wide, which looks like a flat plateau extending beyond the edge of the fovea.

Notes:

- In some cases, lipping around the fovea merges with an adjacent area of roughening on the femoral head (see Femoral Head Roughening, pg. 49).
- Rarely the fovea is small and appears filled in with bone with no margin clearly separable from the interior. These atypical femora are not scored for this trait.

Examples:



FFML-1 Absent
The margins of the fovea are slightly raised, but are smooth and rounded. (ID#:2727)



FFML-2 Absent
The fovea has a raised and sharp, but regular, margin. For lipping to be present, the bone growth around the fovea must be irregular. (ID#:1143)



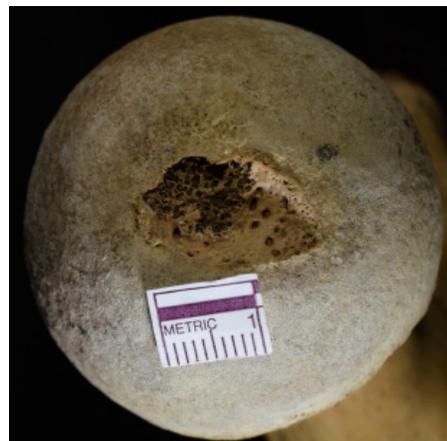
FFML-3: Lipped
The entire fovea is slightly irregular with some postmortem damage present on the inferior border. (ID#:2000)



FFML-4: Lipped
The entire fovea has a thick, irregular rim. (ID#:1552)



FFML-5: Lipped
(ID#:2693)



FFML-6: Unscorable
The fovea cannot be scored because more than 10 mm of the fovea is damaged. It is not possible to tell how much lipping was originally present. (ID#:2733)

Femur head surface extra bone [bilateral]

Location: the femoral head, excluding the area in immediate proximity to the articulation margin with the femoral neck (edge of the femoral head)

Scores: 0. absent 1. extra bone (5-9.9 mm)
2. extra bone (≥ 10 mm)

Absent: The normally smooth articulation surface of the femoral head is either smooth, or has < 5 mm of a bone deposit. If pitting (removal of bone from the surface) is present, it should be ignored.

Extra bone: Extra bone measuring ≥ 5 mm in its longest dimension is present on the articulation surface.

Notes:

- Sometimes lipping of the fovea margin and the rough femoral surface area join one another.
- Often the rough area lies immediately alongside the fovea, and it may join the lipping that defines the fovea's edge. The bone deposits, however, can be islands of rough-looking bone separated by as much as a centimeter or more from the fovea. In the intervening area, the original smooth subchondral bone is visible.

Examples:



FHSR-1: Absent
The entire femoral head is smooth. (ID#:2727)



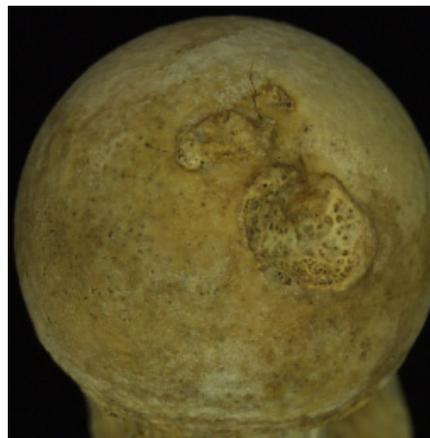
FHSR-2: Absent
An area of pitting is present, but there is not more than 5 mm of extra bony growth. (ID#:2260)



FHEB-3: Absent
The surface is slightly roughened but < 5 mm of additional bone growth is present. (ID#:2039)



FHEB-4: Extra bone (≥ 5 mm)
The surface is slightly pitted, but more than 5 mm of additional bony growth is present. (ID#:2734)



FHEB-5: Extra bone (≥ 5 mm)
(ID#:2315)



FHEB-6: Extra bone (≥ 10 mm)
(ID#:1876)

Femur greater trochanter roughening (lateral surface) [bilateral]

Location: the lateral surface and lateral-inferior edge of the greater trochanter

Scores: 0. absent 1. rough (triangle)
 2. rough (rectangle) 3. overhang

Absent: The bone is smooth, or only a small area (<10 x 20 mm triangle) is rough.

Rough (minor): A 10 x 20 mm triangle of slightly to extensively rough bone is present on the surface.

Rough (major): A 10 x 20 mm rectangle of bone is slightly to extensively roughened by the addition of flat to irregular bone growth on top of the trochanter's original smooth surface. No overhang of sufficient size is present.

Overhang: Irregular bony growth extends ≥ 1 mm distally from the original surface of the bone for ≥ 10 mm horizontally along the greater trochanter's inferior margin. When viewed anteriorly or posteriorly, there is a gap between the femur shaft and the extra bone growth (i.e., an overhang).

Examples:



FGTR-1: Overhang
Lateral (a) and posterior (b) views of an overhang. The roughened bone on the posterior view (a) is characteristic of the type of deposits scored in both roughened categories. (ID#:1831)



FGTR-2: Overhang
(ID#:1919)



Femur trochanteric fossa exostoses [bilateral]

Location: depths of the trochanteric fossa where the obturator externus inserts

Scores: 0. absent 1. present

Absent: The area is smooth with little or no evidence of generally sharp exostoses. A single exostosis is considered absent.

Present: At least two exostoses are clearly visible in the depths of the fossa. Occasionally the exostoses will merge into a single large area with multiple peaks, and it is also scored as present.

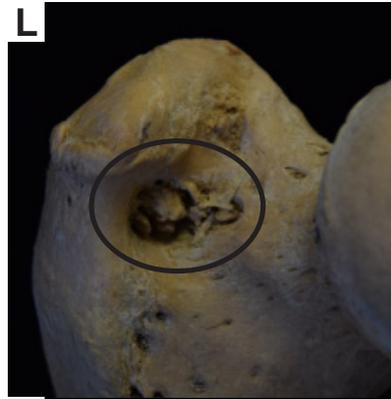
Examples:



FTFE-1: **Present**
(ID#:2727)



FTFE-2: **Present**
Exostoses located (L) within and (R) slightly superior to the depths of the trochanteric fossa. (ID#:2328)



FTFE-3: **Present**
L&R: Both the trochanteric fossa (circled) and medial trochanteric fossa exostoses are present. R: The fossa exostoses have merged into a single large spike with multiple peaks. (ID#:1800)



FTFE-4: **Present**
(ID#:1808) Image reversed.



FTFE-5: **Present**
(ID#:1876) Image reversed.

Femur trochanteric medial exostoses [bilateral]

Location: area immediately proximal to the trochanteric fossa on the medial side of the proximal end of the greater trochanter where obturator internus and gemelli insert

Scores: 0. absent 1. present

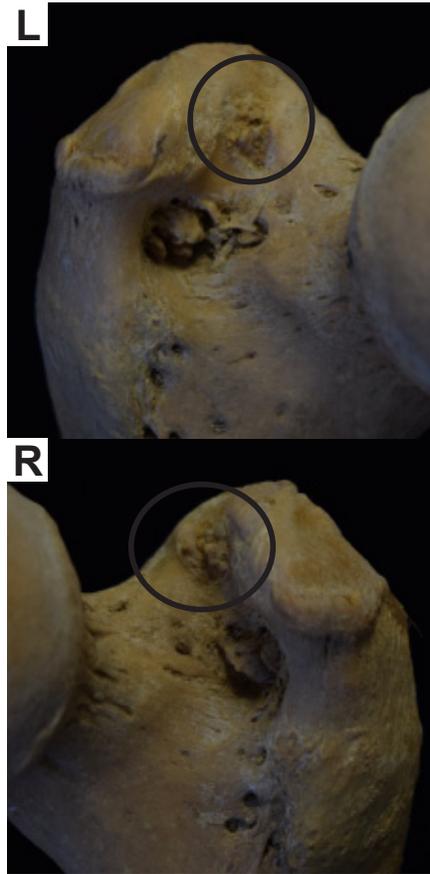
Absent: The area is smooth or has, at most, a single exostosis.

Present: A patch of ≥ 2 exostoses, similar to those seen in the trochanteric fossa, are present.

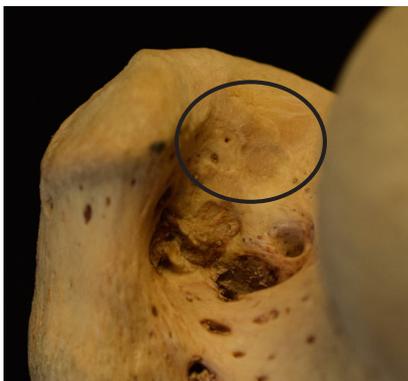
Notes:

- The exostoses generally form a distinctly rough patch of bone that is separate from the similar patch of roughened bone deep within the trochanteric fossa. The two areas are occasionally confluent.
- Occasionally the exostoses take the form of a rough raised rim surrounding a small oval tendon insertion.
- In some individuals, this area has low raised, but regular, ridges that do not extend off the surface of the bone. In the absence of raised, distinct exostoses, the feature should be scored as absent.

Examples:



FTFME-3: Present
L&R: Both trochanteric fossa and medial trochanteric fossa (circled) exostoses are present. (ID#:1800)



FTFME-1: Absent
(ID#:2727)



FTFME-4: Present
(ID#:1808) Image reversed.



FTFME-2: Absent
Low rounded linear elevations that are not irregular additions of bone. Compare these to FTFME-6. (ID#:2486)



FTFME-5: Present
Exostoses are almost merging with those in the trochanteric fossa. (ID#:2730)



FTFME-6: Present

Atypical exostoses expressed as raised ridges. Compare to FTFME-2. (ID#:1954) Image reversed.



FTFME-7:

Present

Small exostoses (circled) are located slightly more lateral than where they are typically found (arrow). Although the location of exostoses in this region may vary slightly, exostoses located on the proximal portion of the greater trochanter should not be scored. (ID#:2547)

Tibia weight [bilateral]

Location: the entire tibia

Scores: 0. normal 1. light

Normal: The bone weight falls within what one might expect for an individual of that size. Bones that are borderline, or only slightly lighter than normal, should be scored as normal. This observation is subjective, so err on the side of classifying the bone as normal.

Light: The bone must be noticeably lighter than expected, but otherwise normal in appearance. A light tibia is often little more than a cortical bone shell.

Notes:

- This trait should be recorded or, at least, mentally noted, when the bones are first picked up, usually when unpacking the skeleton's box. Handling bones for some time before scoring can result in skewed perceptions of relative bone weight.
- In only rare cases will bone weight be asymmetric. When that occurs, record both sides and make a note on the data collection form.

Tibia weight (metric)

A rough approximation of bone "density" should also be obtained metrically whenever the bone is complete based on:

- maximum length measured using a standard osteometric board and rounded to the nearest whole millimeter
- weight measured using a digital scale and recorded to the nearest whole gram

Fibula wings [bilateral]

Location: the lateral surface and anterior edge of the lateral malleolus where the anterior talofibular and anterior tibiofibular ligaments attach

Scores: 0. absent 1. present

Absent: The feature is entirely absent, or the bony growth does not extend 1 mm anteriorly beyond the margin of the fibula for a full 3 mm in a proximal to distal direction.

Present: There is a projection of bone ≥ 1 mm beyond the anterior margin of the fibula for ≥ 3 mm in length (i.e., at least a 1 x 3 mm rectangle). The anterior margin of the projection is typically irregular and its surface has multiple striations paralleling the long axis of the feature. This extension of bone, which continues onto the lateral surface of the fibula, has a smooth, sclerotic appearance.

Notes:

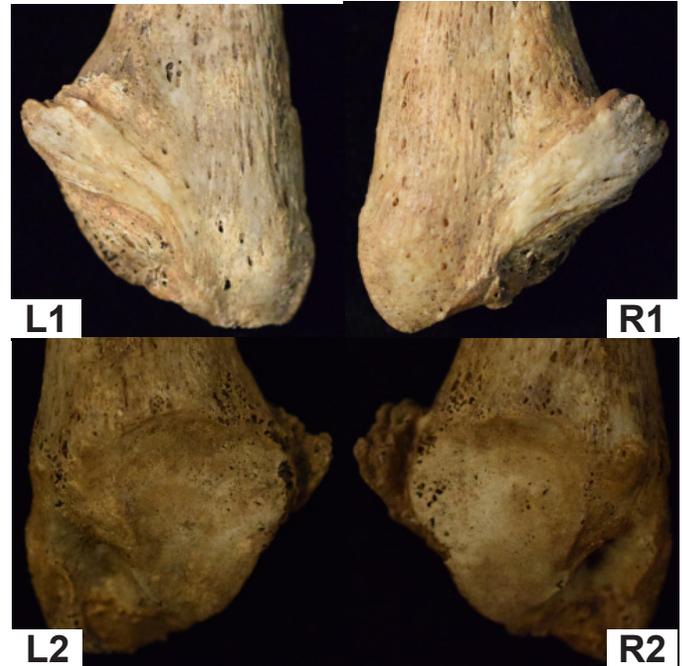
- The most important feature is the amount of projection beyond the fibula's anterior margin. The other aspects of the feature, described above, are included in the definition because they often are the most apparent characteristic when the bone is first handled.

Examples:



FW-1: Absent

Lateral (a) and medial (b) surfaces of a left fibula. A few faint striations are present on the lateral surface, but there is no ossification beyond the anterior border. In (b), slight postmortem damage makes the anterior border slightly irregular. (ID#:2547)



FW-2: Present

Views of the lateral (1) and medial (2) surfaces. On the lateral surface there is obvious sclerotic ossification. The extension and length of the ossification (at least 1 mm extension x 3 mm length) can be most easily measured by looking at the medial surface. (ID#:2659)



FW-3: Present

Lateral (a) and medial (b) surfaces of a left fibula. (ID#:2325) Specimen number removed from (b).

Calcaneus weight [bilateral]

Location: the entire calcaneus

Scores: 0. normal 1. light

Normal: The bone weight falls within what one might expect for an individual of that size. Bones that are borderline, or only slightly lighter than normal, should be scored as normal. This observation is subjective, so err on the side of classifying the bone as normal.

Light: The bone must be noticeably lighter than expected. The cortical bone is often extremely fragile and paper-thin.

Notes:

- This trait should be recorded or, at least, mentally noted, when the bones are first picked up, usually as the skeleton's box is unpacked. Handling bones for some time before scoring can result in skewed perceptions of relative bone weight.
- In only rare cases will bone weight be asymmetric. When that occurs, record both sides and make a note on the data form.

Calcaneus weight (metric)

A rough approximation of bone "density" should also be obtained metrically whenever the bone is complete based on:

- maximum length measured using a standard osteometric board and rounded to the nearest whole millimeter
- weight measured using a digital scale and recorded to the nearest whole gram

Innominate weight [bilateral]

Location: the entire innominate

Scores: 0. normal 1. light

Normal: The bone weight falls within what one might expect for an individual of that size. Bones that are borderline, or only slightly lighter than normal, should be scored as normal. This observation is subjective, so err on the side of classifying the bone as normal.

Light: The bone must be noticeably lighter than expected, but otherwise normal in appearance. In light innominates, the cortical bone is often extremely fragile and paper-thin.

Notes:

- This trait should be recorded or, at least, mentally noted, when the bones are first picked up, usually as the skeleton's box is unpacked. Handling bones for some time before scoring can result in skewed perceptions of relative bone weight.
- In only rare cases will bone weight be asymmetric. When that occurs, record both sides and make a note on the data form.

Innominate weight (metric)

A rough approximation of bone "density" should also be obtained metrically whenever the bone is complete based on:

- maximum height measured using a standard osteometric board and rounded to the nearest whole millimeter
- weight measured using a digital scale and recorded to the nearest whole gram

Sacroiliac joint fusion [bilateral]

Location: the sacroiliac joint

Scores: 0. normal 1. fused 2. superior-anterior (SA)

Absent: If no bony union exists between the two elements, the trait is absent.

Fused: The sacrum is fused to the ilium through bony ossifications in any location. The location of the fusion should be noted.

Superior-anterior fusion (SA): The sacrum and ilium are fused via a bony connection in the region where the anterior sacroiliac ligament exists.

Notes:

- If the sacrum, innominate, or both show damage in the region of the sacroiliac joint, they should be examined closely to determine if a bony connection between the two was broken postmortem (e.g., SAF-5).

Examples:



SAF-1: Present
Unilateral superior-anterior (SA) fusion with a small band of ossification (arrow) (ID#:2301) Specimen number removed from image.



SAF-3: Present
Bilateral superior-anterior fusion. (ID#:2396) Specimen number removed from image.



SAF-2: Present
Unilateral superior-anterior (SA) fusion with ossification spanning most of the superior portion of the joint. (ID#:1901)



SAF-5: Present
Superior-anterior fusion that has been broken postmortem and rearticulated for the photo. Arrow indicates the location of the break. (ID#:2725) Specimen number removed from image.

Iliac crest fusion [bilateral]

Location: the most superior part of the iliac blade anterior to, and including, the iliac tubercle

Scores: 0. not fused (NF) 1. partially fused (PF)
2. remnant line (RL) 3. fully fused (FF)

Not fused (NF): The epiphysis is not present and the underlying epiphyseal surface is visible.

Partially fused (PF): The epiphysis is only partly joined to the blade of the ilium. The edges of the epiphysis are sharp and the bottom of the groove between the epiphysis and iliac body is open. In many cases, the partially fused epiphysis is partly broken from the iliac blade.

Remnant line (RL): The epiphysis is completely fused, but not fully integrated into the ilium. A shallow but distinct channel, at least 10 mm long, with a fused bottom is present.

Fully fused (FF): There is no evidence of where the epiphysis has fused.

Examples:



ICF-1: **Not fused**
Anterior oblique view of an unfused iliac crest. (ID#:1125)



ICF-2: **Partially fused**
View of the external surface. The epiphysis is attached to the body of the ilium, but the bottom of the groove between the bones is open (unfused). (ID#:1780)



ICF-3: **Partially fused**

A fusing iliac crest viewed from the (a) internal and (b) external surfaces. The posterior half of the iliac crest is not fused, but is outside the scoring area. (ID#:2735) Specimen number removed from image (b).



ICF-4: **Remnant line**
(ID#:1841)



ICF-5: **Remnant line**
(ID#:2729)



ICF-6: **Remnant line**
(ID#:1143)

Iliac crest tuberculum ossification [bilateral]

Location: the area of the iliac crest from the tuberculum (iliac tubercle) – a rounded prominence on the edge of the iliac crest posterior to the anterior superior iliac spine – to halfway to the anterior superior iliac spine

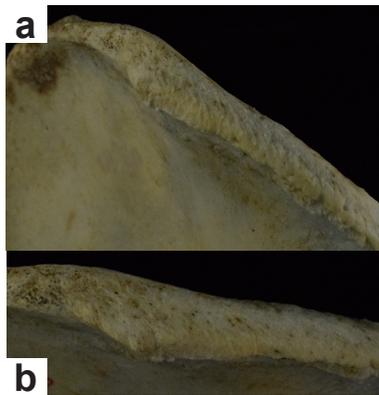
Scores: 0. absent 1. ossification
 2. double ossification

Absent: No ossification is present, or it does not meet the size requirements.

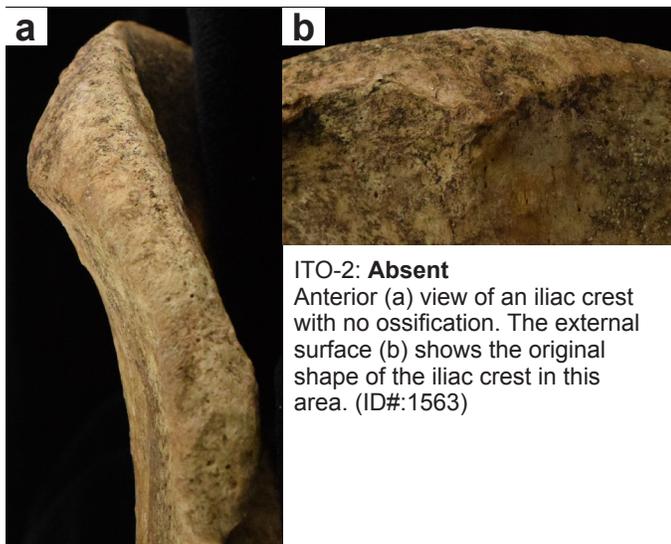
Ossification: Ossification occurs on the lateral edge of the iliac tuberculum where fascia attaches in life. It must extend outward from the original border of the iliac crest for ≥ 3 mm for ≥ 10 mm along the iliac crest.

Double Ossification: Double ossification occurs when two (rarely more) distinguishable rows of ossification each extend away from the original border of the iliac crest for ≥ 3 mm along ≥ 10 mm of the crest.

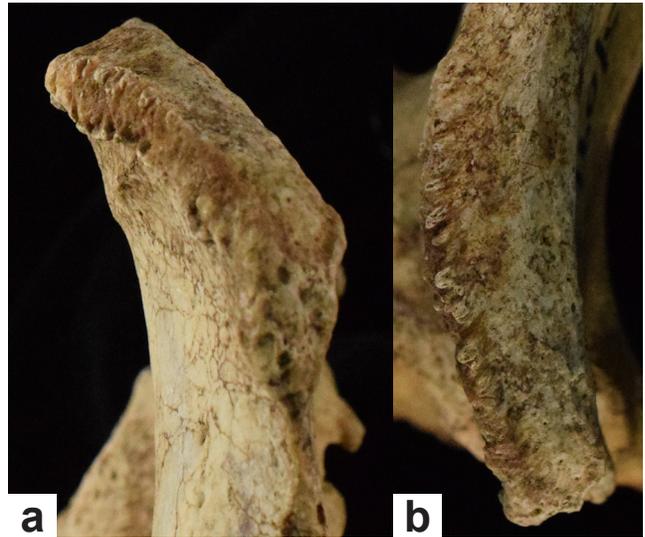
Examples:



ITO-1: Absent
Anterior-oblique (a) and superior-oblique views of a slightly roughened iliac crest. No ossifications extend off the original bone surface. (ID#:1452)



ITO-2: Absent
Anterior (a) view of an iliac crest with no ossification. The external surface (b) shows the original shape of the iliac crest in this area. (ID#:1563)



ITO-3: Absent
Anterior (a) and superior (b) views of slight ossifications that do not meet the length and extension requirements to be considered present. (ID#:1566)



ITO-4: Ossification
A single ossification (at least 3 x 10 mm) is present (ID#:1442)



ITO-5: Double Ossification
Two layers of ossification (at least 3 x 10 mm) are present. (ID#:1380)

Ilium AIIS exostoses (anterior inferior iliac spine exostoses) [bilateral]

Location: surface of the anterior inferior iliac spine

Scores: 0. absent (<75%) 1. exostoses (≥75%)

Absent: The surface is smooth or, if exostoses are present, the roughened area covers <75% of the surface.

Exostoses: Numerous low rounded elevations of bone (exostoses) produce a rough surface that cover ≥75% of the anterior inferior iliac spine (AIIS).

Notes:

- Small exostoses can give the bone a slightly roughened appearance. If <25% of the surface of the AIIS shows original, smooth, unmodified bone, the feature should be considered present (exostoses).

Examples:



AIIS-1: **Smooth**
(ID#:1005)



AIIS-3: **Present**
(≥75%)
(ID#:1876)



AIIS-1: **Smooth**
(ID#:2727)



AIIS-4: **Present**
(≥75%)
(ID#:2659)

Acetabulum posterior margin lipping [bilateral]

Location: the 30 mm forming the posterior portion of the acetabulum's outer margin

Scores: 0. absent 1. present (≥ 10 mm)

Absent: The outer edge of the acetabulum is smooth and it can be either round or sharp. That is, in cross-section the rim is U- or V-shaped from the articulation (joint) surface to the outer surface of the bone.

Present: In the present category, noticeable and irregular bony lipping occurs along a continuous ≥ 10 mm of the acetabulum's margin.

Notes:

- When lipping is present, traces of the original edge of the joint are often still visible. The lipping extends outward from the original edge. Frequently the easiest way to visualize the lipping is when viewing the bone from the acetabular surface.

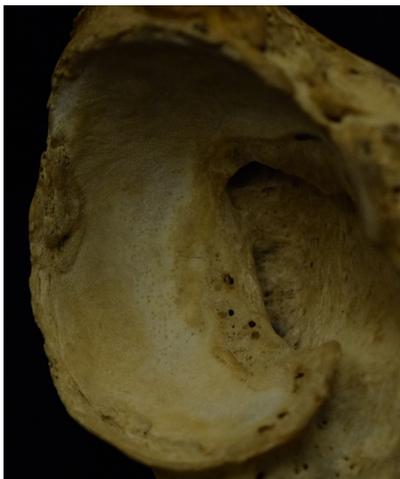
Examples:



APML-1: **Absent**
(ID#:1804)



APML-3: **Present (≥ 10 mm)**
(ID#:2022) Image reversed.



APML-2: **Present (≥ 10 mm)**
(ID#:2328)



APML-4: **Present (≥ 10 mm)**
(ID#:1380) Image reversed.

Acetabulum articular surface extra bone (posterior) [bilateral]

Location: the lateral posterior portion of the articular (joint) surface of the acetabulum, just inside the joint margin. The joint surface in the same region as the posterior acetabular margin described above

Scores: 0. absent 1. present (≥ 5 mm)

Absent: The normally smooth articulation surface of the acetabulum is either smooth, or has < 5 mm of additional bone growth. If pitting (removal of bone from the surface) is present, it should be ignored.

Present: An area of extra bone measuring ≥ 5 mm in its longest dimension is present on the articulation surface.

Notes:

- The irregular bony growth is typically separated from the joint margin, and any lipping that might occur there, by a narrow strip of the original joint surface. However, there are occasions when the margin lipping and joint surface roughening are immediately adjacent to one other.

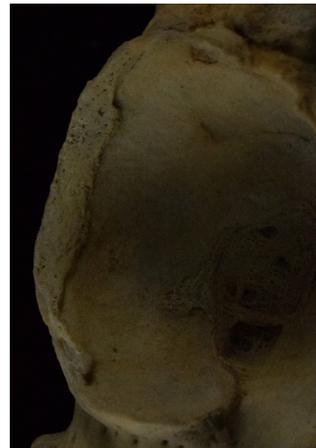
Examples:



APMR-1: **Absent**
(ID:1804)



APMR-2: **Absent**
Additional bone is present on the articular surface, but it is smooth and regular. This is not the irregular bony growth characteristic of this trait. Compare with APMR-4. (ID#:2020)



AASEB-3: **Present (≥ 5 mm)**
(ID#:1388)



AASEB-4: **Present (≥ 5 mm)**
(ID#:1786) Image reversed.



AASEB-5: **Present (≥ 5 mm)**
(ID#:1876)



AASEB-6: **Present (≥ 5 mm)**
(ID#:2133)

Acetabulum inferior joint lipping [bilateral]

Location: margin of the inferior end of the acetabular articulation surface

Scores: 0. absent 1. lipped (≥ 3 mm)

Absent: Lipping is absent or projects outward < 3 mm.

Lipped: Lipping is present that projects ≥ 3 mm outward from the original margin of the articular surface.

Examples:



AIJL-1: **Absent**
Lipping is present but is not long enough to be scored as present. (ID#:1006)



AIJL-2: **Present (≥ 3 mm)**
(ID#:2736)



AIJL-3: **Present (≥ 3 mm)**
Extensive joint lipping that almost meets an ossification from the superior portion of the joint. (ID#:1876)



AIJL-5: **Present (≥ 3 mm)**
Extensive joint lipping that spans the gap between the superior and inferior portions of the acetabular joint surface forming a complete circle. (ID#:1675) Image reversed.

Ischial tuberosity superior margin spur [bilateral]

Location: the superior margin of the ischial tuberosity where fascia for the semimembranosus attaches

Scores: 0. absent
1. present (≥ 3 mm high and ≥ 10 mm long)

Absent: The distinctive bony crest or spur is absent, or it does not meet the size criteria.

Present: A narrow and irregular bony crest or spur ≥ 3 mm high and ≥ 10 mm long is present. The prominent bony growth is often wave-like with its crest curving over the ischial tuberosity.

Notes:

- Bony growth that occurs on the anterior margin or inferior portion of the ischial tuberosity should not be scored.

Examples:



ITSMS-1: **Absent**
The epiphysis is unfused, so the trait is "absent." (ID#:1125)



ITSMS-2: **Absent**
The superior margin is completely smooth. (ID#:1804)



ITSMS-3: **Absent**
The superior margin is slightly raised, but no irregular ossification is present. (ID#:2464)



ITSMS-4: **Absent**
There is a raised mound along the superior margin (arrow) but no distinctive bony crest extends off the raised surface. (ID#:2006)



ITSMS-5: **Absent**
Some lipping is present (circle), but it does not meet the height and length requirements. (ID#:2604)



ITSMS-6: **Absent**
Some irregular bony growth is present, but it does not extend away from the surface for ≥ 3 mm. (ID#:1876)



ITSMS-7: **Present**
An ossification ≥ 10 mm long and ≥ 3 mm high is present along almost the entire superior border. (ID#:2297)



ITSMS-8: **Present**
(ID#:2460)

Ischial tuberosity medial spur (sacrospinous ligament spur) [bilateral]

Location: inferior third of the medial border of the ischial tuberosity where the sacrotuberous ligament attaches to the tuberosity's margin

Scores: 0. absent 1. present (≥ 10 mm high)

Absent: No ossification is present or, if present, is < 10 mm long.

Present: A distinct and narrow bony ossification extends medially for ≥ 10 mm beyond the edge of the ischium.

Examples:



ITMS-1: Absent
The medial border of the ischial tuberosity is smooth with no ossification. (ID#:1804)



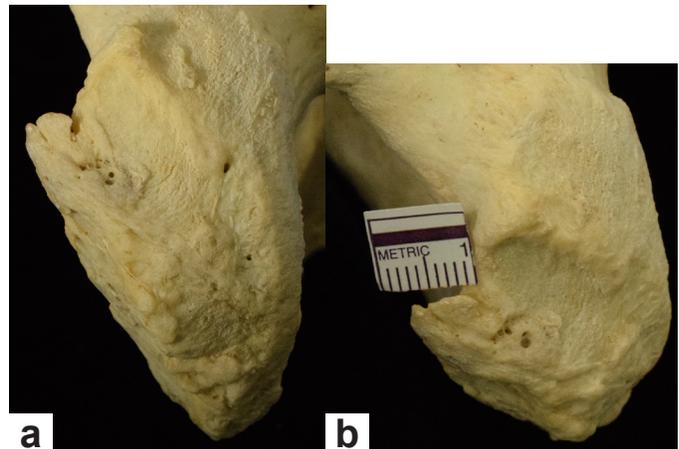
ITMS-2: Absent
The medial border of the ischial tuberosity has no ossification present. (ID#:2464)



ITMS-3: Absent
The spur is present (arrow), but it does not extend < 10 mm. (ID#:2404)



ITMS-4: Absent
The spur is present (arrow), but it does not extend away from the surface of the bone by ≥ 10 mm. (ID#:1566)



ITMS-5: Absent
Anterior (a) and oblique (b) views of a small medial spur that does not extend off of the surface of the bone by ≥ 10 mm. Images reversed. (ID#:1485)



ITMS-6: Present
(ID#:2460)



ITMS-7: Present
(ID#:1709)



ITMS-8: Present
(ID#:2297)

AURICULAR SURFACE

Inferior surface porosity [bilateral]

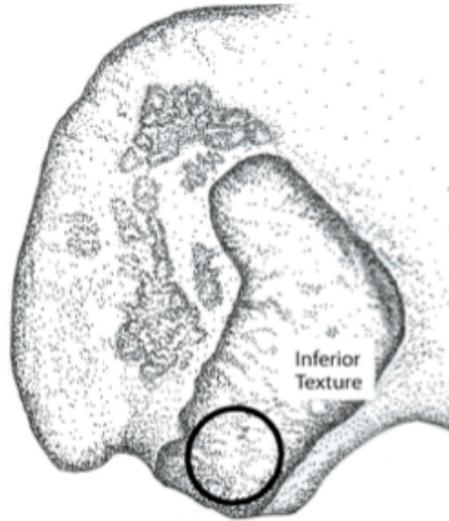
Location: most inferior 10 mm (in a superior to inferior direction) of the inferior demiface – do not include any marginal lipping that extends beyond the original margin of the joint surface

Scores: 0. smooth 1. porosity (microporosity or macroporosity $\geq 1/2$ of the area)

Absent: There is little or no porosity in the scored area.

Present: Microporosity, macroporosity, or a combination of the two, covers $\geq 1/2$ of the scored area.

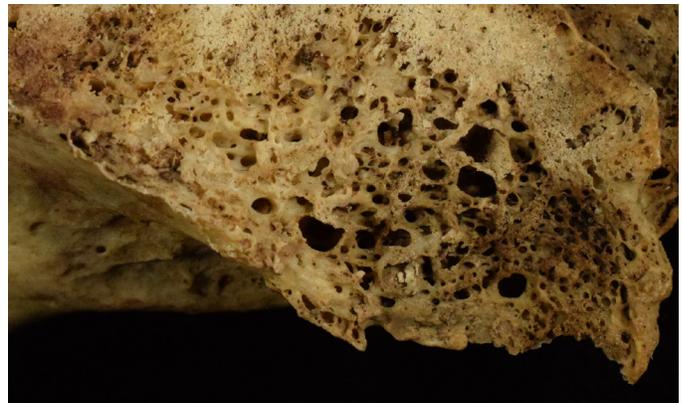
Examples:



ASIF Fig. 1: Scoring location for inferior surface porosity.



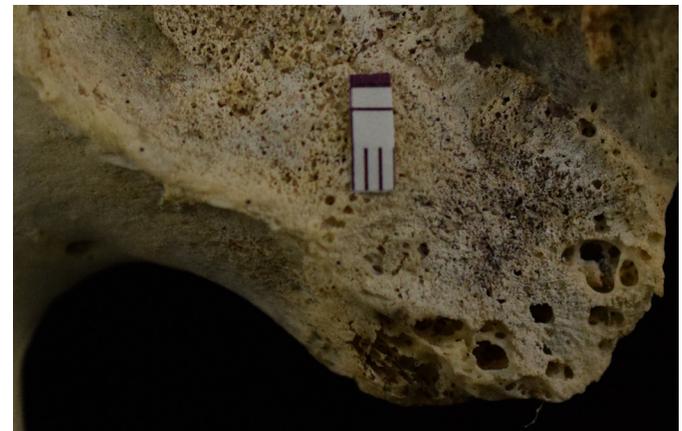
ASIP-1: **Absent**
Some microporosity is present on the inferior portion of the auricular surface, but it does not cover at least one-half of the area. (ID#:2737)



ASIP-3: **Porosity**
(ID#:1488)



ASIP-2: **Porosity**
More than half of the inferior 10 mm of the auricular surface is covered in micro- and macroporosity. The area formed by additional lipping beyond the original end of the joint (red line) is not scored. (ID#:1552)



ASIP-4: **Porosity**
A combination of micro- and macroporosity covers essentially the entire scoring area. (ID#:1786)

Superior posterior iliac exostoses [bilateral]

Location: medial surface of the posterior ilium where the ventral sacroiliac ligament attaches; in some individuals the bone is distinctly raised in this area

Scores: 0. smooth 1. exostoses (rounded, pointed, jagged)

Smooth: The area is almost entirely smooth with, at most, one isolated small exostoses present.

Exostoses: More than one exostosis, (rounded, pointed, or jagged in appearance) is present.

Notes:

- Sometimes the exostosis can take the form of an elongated ridge up to 10mm long. If the ridge is a dominant feature of this part of the bone, the trait is scored as exostoses.
- When there is an articulation facet between the ilium and the sacrum that obscures the scored area or, when the bones are fused, the trait is not scored. However, if a facet is present and exostoses are also distinctly visible then it can be scored as exostoses.

Examples:



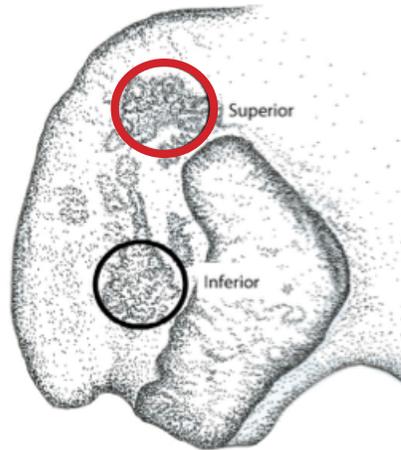
ASSIE-1: Smooth

The roughened texture of the developing retro-auricular area in very young adults should not be confused with the ossifications that develop later in life. (ID#:1125)



ASSIE-2: Exostoses

The scoring area (circled) has several small, low, rounded exostoses (arrows). (ID#:1143)



ASSIE Fig. 1: Scoring locations of the superior posterior iliac exostoses.



ASSIE-3:
Exostoses
(ID#:2359)



ASSIE-4:
Exostoses
Some postmortem damage is present in the scoring area, but exostoses are still identifiable. (ID#:1472)



ASSIE-5:
Exostoses
An articulation facet is present, but extra bony growth is present around the facet. (ID#:2363)

Inferior posterior iliac exostoses [bilateral]

Location: medial surface of the posterior ilium where the interosseous sacroiliac ligament attaches; in some individuals, the bone is distinctly raised in this area

Scores: 0. smooth 1. exostoses (rounded, pointed, or jagged)

Smooth: The area is almost entirely smooth with, at most, one isolated small exostosis present.

Exostoses: More than one exostosis, (rounded, pointed, or jagged in appearance) is present.

Notes:

- When there is an articulation facet between the ilium and the sacrum that obscures the scored area or when the bones are fused, the trait is not scored. However, if a facet is present and exostoses are also distinctly visible, then it can be scored as exostoses.

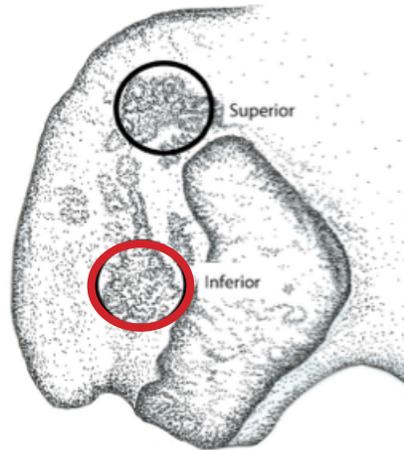
Examples:



ASPIE-1: **Exostoses**
(ID#:1143)



ASPIE-2: **Exostoses**
(ID#:2359)



ASPIE Fig. 1:
Scoring locations of
the inferior posterior
iliac exostoses.



ASPIE-3: **Exostoses**
(ID#:2363)



ASPIE-4: **Exostoses**
Low rounded exostoses cover the entire inferior scoring area.
(ID#:2517)

Posterior exostoses [bilateral]

Location: the posterior iliac area lies between the superior and inferior posterior iliac exostoses (as defined above)

- The area where the exostoses occur is on the medial side of the ilium bordered posteriorly by the iliac crest, anteriorly by the sacroiliac joint surface, superiorly by a slightly raised area often surmounted by bony exostoses (superior posterior iliac exostoses), and inferiorly by a similar area (inferior posterior iliac exostoses)
- Excluded is a 5-10 mm wide area of bone immediately posterior to the auricular surface where no exostoses ever form (e.g., ASPE-7).

Scores: 0. smooth 1. discontinuous exostoses
2. continuous exostoses

Absent: There are no exostoses in the scored area. It is completely smooth.

Discontinuous exostoses: There is at least one exostosis in the area, often many of them, but they do not collectively cover the entire area of interest. That is, the exostoses often look like islands in a sea of flat bone.

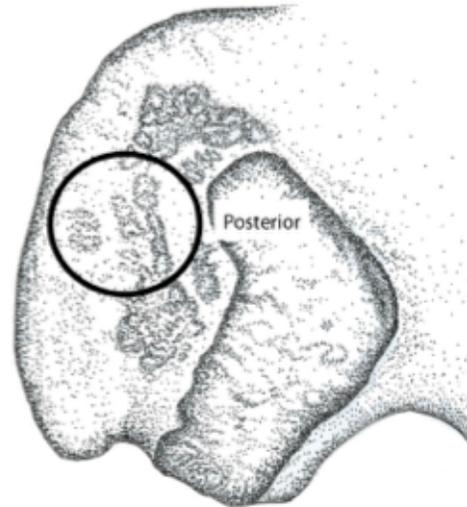
Continuous exostoses: The area between the places where superior and inferior posterior iliac exostoses form must be entirely covered with low, rounded or pointed exostoses. The low exostoses give the normally smooth iliac surface a rough appearance. The surface, completely covered by exostoses, often looks as if a layer of coarse sand was laid over it. Little, if any, of the original smooth bone surface is visible.

It is important to realize that a strip of bone immediately posterior to the articulation surface is rarely, if ever, the site of exostoses. This area is excluded when scoring the bone.

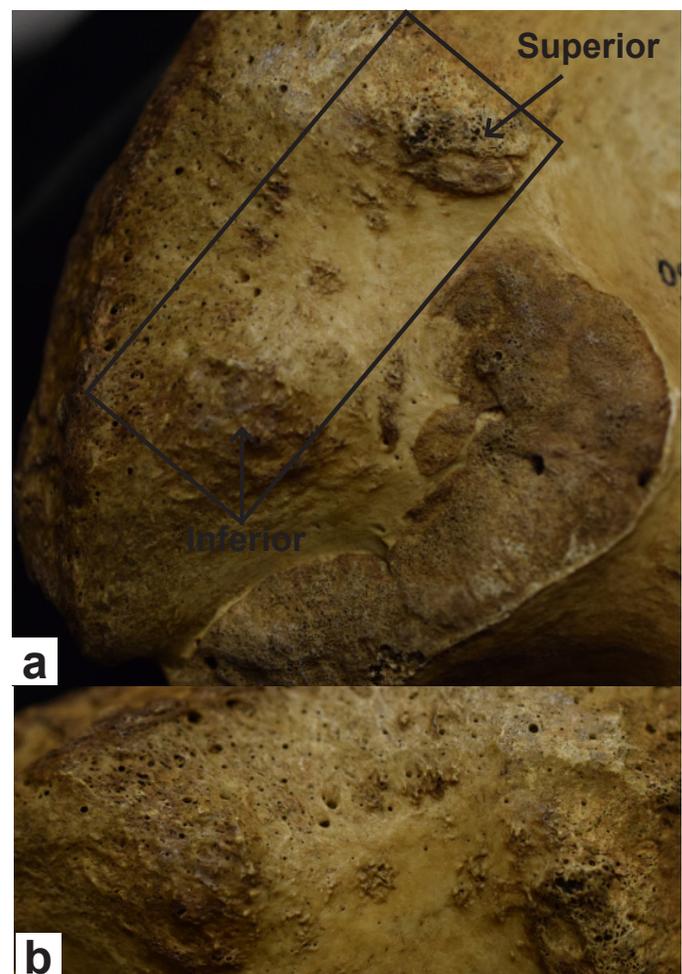
Notes:

- The ilium and sacrum can be fused in several places. If that occurs, the posterior exostoses are not observable.
- The vast majority of individuals fall into the discontinuous exostoses category.

Examples:

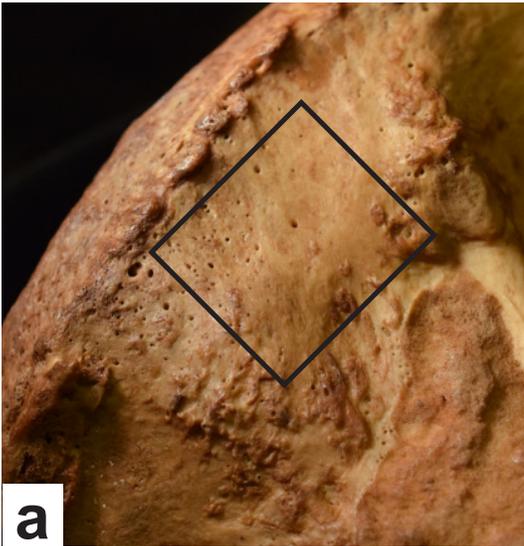


ASPE Fig. 1: Scoring locations of the posterior exostoses.



ASPE-1: Discontinuous exostoses

The area between the scoring areas for the superior and inferior exostoses is mostly smooth, dense bone, but several small bony growths are present on the surface. Box indicates the area enlarged in (b). (ID#:2359)

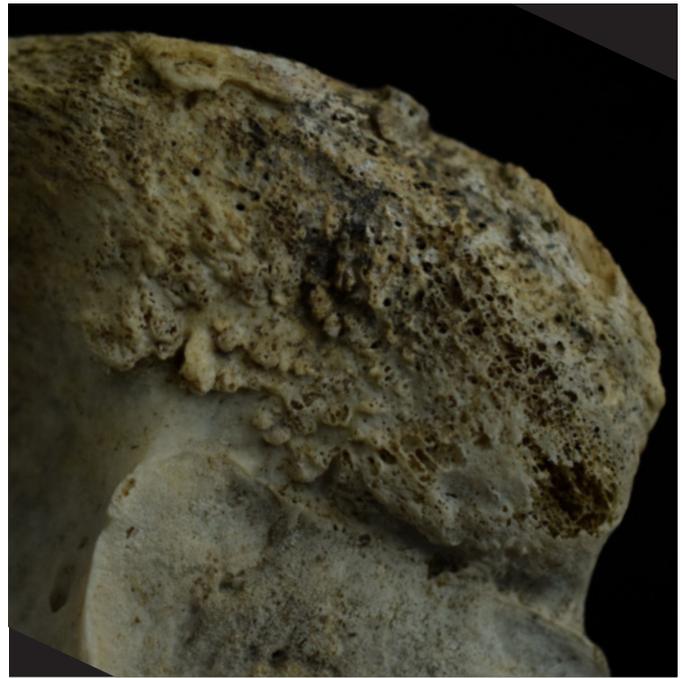


a



b

ASPE-2: **Discontinuous exostoses**
 The majority of the area is smooth dense bone, but several small bony growths are present on the surface. Box indicates the area enlarged in (b). Several exostoses are indicated (arrows) as examples. Image reversed. (ID#:2363)



ASPE-4: **Continuous exostoses**
 (ID#1747)



ASPE-5: **Continuous exostoses**
 The entire surface is covered by exostoses, except for the smooth area just posterior to the border of the auricular surface that is excluded from the scoring area. (ID#:1369)



ASPE-3: **Continuous exostoses**
 Slightly oblique view of a surface entirely covered by low rounded exostoses. Essentially none of the original smooth bone surface is visible between the bony growths. (ID#:2517)

PUBIC SYMPHYSIS

Pubic symphyseal collar [bilateral]

Location: immediately anterior to the ventral margin of the pubic symphysis

Scores: 0. absent 1. collar

Absent: There is no extra bony growth or, if present, it is <10mm long

Collar (≥ 10 mm) : Extra extra bony growth with the appearance of ossified ligaments anterior and parallel to the ventral border of the symphyseal face that extends for ≥ 10 mm. The ossification can be continuous or in multiple segments of several millimeters that collectively sum to ≥ 10 mm.

The bony growth usually extends inferiorly from the superior ventral part of the symphyseal face, but can be present elsewhere along the ventral border. The ossification must be at the same height as a plane defined by the symphyseal face, and it is separated from the face by a narrow groove.

In other words, moving anteriorly from the symphyseal face, one would encounter the ventral plateau, the anterior symphyseal margin (typically marked by a rim or its breakdown), a narrow channel, and finally the collar.

Notes:

- A collar should not be confused with the small ligamentous ossifications that often form on the anterior pubic surface near the symphyseal margin. To be scored as present, the ossifications must be at the same level as the symphyseal face for ≥ 10 mm.
- Care should be taken not to confuse the collar with rim breakdown, because the collar can appear to be the dominate (most noticeable) feature in this area.
- When there is a ventral hiatus, the collar is still located anterior to the symphyseal face; it should not be confused with the face's margin. There is typically a relatively deep depression between the anteriorly located collar and the posteriorly located dorsal demiface (that is because the majority of the ventral rampart never formed in this area).



PSSC-1: Collar
Both the right and left collars extend only along the superior one-third of the joint. (ID#:2488)



PSSC-2: Collar
The collar extends along the entire ventral edge. (ID#:2460)



PSSC-3: Collar
(ID#:1786)



PSSC-5: Collar
In rare cases, the collar extends onto the symphyseal face.
(ID#:2661)



PSSC-4: Collar
(ID#:1564)



PSSC-6: Collar
(ID#:1572)

Symphyseal relief [bilateral]

Location: the entire symphyseal face (Fig. 1)

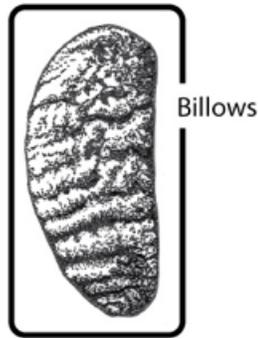
Scores: 0. billows 1. residual 2. flat/irregular

Billows: Clearly visible and discrete elevations, from sharply crested ridges to low rounded hills, cover the most of the surface. The overall impression of the symphyseal face is one of a series of parallel low ridges (billows).

Residual: The overall impression is that the symphyseal face is flat, but at least two consecutive billows are present. The residual billows are often barely visible, being only slightly elevated above the symphyseal face. They are often hard to detect except in good light and upon close examination.

Flat: At most one billow is present. A flat or slightly recessed face can be surrounded by a well-developed rim. Alternatively, the face can be marred by deep pits, small sharp exostoses, or both. Together they give the surface an irregular, disfigured appearance. Often a flat or irregular face is defined by the rim and breakdown stage of the ventral and dorsal margin.

Examples:



PSR Fig. 1: The relief of the entire symphyseal face is scored.



PSR-3: **Billows**
(ID#:1758)



PSR-4: **Billows**
Soft shallow billows cover the majority of the surface.
(ID#:2738)



PSR-1: **Billows**
(ID#:1915)



PSR-2: **Billows**
(ID#:1125)



PSR-5: **Billows**
The same pubic symphysis in direct (a) and angled (b) light. With appropriate lighting it is possible to see that the majority of the surface is covered in low rounded billows. (ID#:2739)



PSR-6: **Billows**
(ID#:2199)



PSR-7: **Billows**
(ID#:2179)



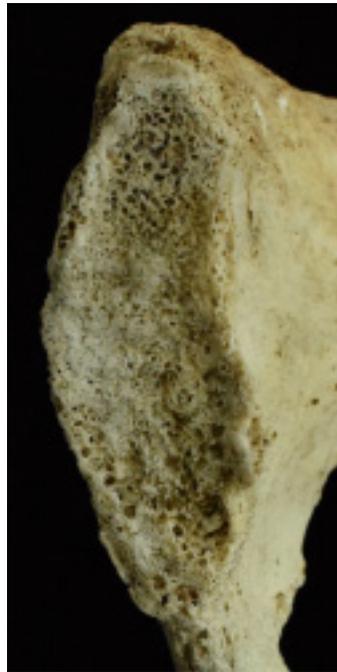
PSR-10: **Residual**
Residual billows on an otherwise young-looking pubic face. (ID#:1843)



PSR-8: **Residual**
At least two consecutive billows are present in the inferior portion of the symphyseal face (arrows). Image reversed. (ID#:2174)



PSR-9: **Residual**
Two consecutive billows are present in the inferior portion of the symphyseal face (arrows). (ID#:1800)



PSR-11: **Flat**
(ID#:1571)



PSR-12: **Flat**
(ID#:2239)

Superior protuberance [bilateral]

Location: the superior part of the symphyseal face

Scores: 0. serrated (no protuberance)
 1. knob (early protuberance)
 2. flat (late protuberance, integrated)

Serrated: When no protuberance is present (serrated), billowing is present in the superior part of the symphyseal face and there are no signs of a bony protuberance.

Knob: A distinct bony knob of variable dimensions with well-defined margins is visible in the superior part of the symphyseal face. It projects above the plane(s) defined by the immediately adjacent symphyseal face (the dorsal demiface, ventral beveled area, or both). The surface of the bony protuberance is typically smooth to fine grained.

Flat: The superior part of the symphyseal face shows little to no sign of a low bony elevation. This stage, the absence of a raised area, is distinguishable from early because the superior portion of the symphyseal face is flat, not the ridge-and-valley surface (rarely an entirely beveled surface) typical of the initial early stage.

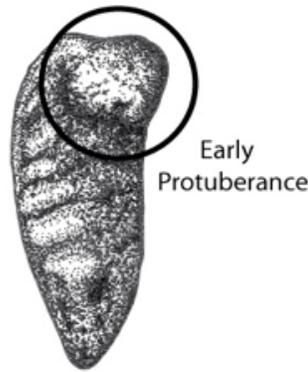
Examples:



SP-1: **Serrated**
(ID#:1913)



SP-2: **Serrated**
(ID#:1125)



SP Fig. 1: Location of the superior protuberance.



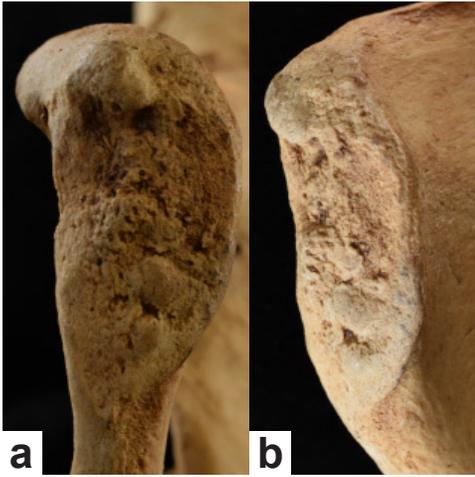
SP-3: **Knob**
 Lateral (a) and posterior (b) views. The superior protuberance has only recently formed. The edges are sharp and the knob of bone looks as though it could easily be removed from the surface. (ID#:1990)



SP-4: **Knob**
 Lateral (a) posterior-oblique (b) views of a small ossific nodule forming on the superior portion of the pubic symphysis. (ID#:2247)



SP-5: **Knob**
 Both a knob and forming ventral rampart are present. (ID#:2015)



SP-6: Flat
Lateral (a) and oblique (b) views of a borderline case. The knob-like ossification on the superior part of the pubis is becoming integrated into the symphyseal face. Once this occurs, the face is considered flat. (ID#:1843)



SP-8: Flat
The superior portion of the pubic face is completely flat. (ID#:1571)



SP-7: Flat
Lateral (a), lateral-oblique (b), and posterior-oblique (c) views of the same pubic symphysis. The borders of the knob are now smooth and integrated into the symphyseal face and surrounding rim. This is similar to SP-6. (ID#:1800)



SP-9: Flat
The irregular ossification in the superior portion of the pubic face should not be confused with a superior protuberance. The bone is irregular and the margins are integrated into the pubic face. (ID#:2239)



Ventral symphyseal margin [bilateral]

Location: ventral margin of the pubic symphysis

Scores: 0. serrated or beveled
1. rampart (forming or complete)
2. rim
3. BD (breakdown)

Serrated or beveled: The ventral rampart has not yet started to form (serrated or beveled). The ventral part of the symphyseal face is either covered with ridges and furrows or is in the process of flattening (beveling) ventrally. In either case, no distinct outgrowths of bone that ultimately form the ventral rampart are present.

Rampart: The rampart is either in the process of forming or is complete, but 10 mm of rim has not yet formed. When forming, the rampart extends from one or both ends of the symphysis. It often resembles a roll of well-chewed gum stuck on the ventral edge of the symphyseal face. The complete rampart presents an uninterrupted flat surface from the dorsal to ventral margins of the symphyseal face (see note about the ventral hiatus).

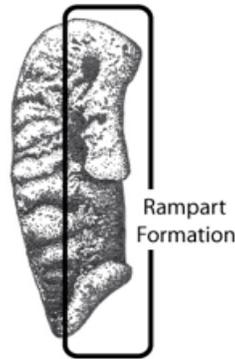
Rim: A narrow, sharp to irregular bony elevation (rim) ≥ 10 mm in length bordering a slightly depressed to irregular symphyseal face must be present. The rim can be either a continuous ridge of bone or several segments, as long as 10 mm in total of elevated border is present. The rim's crest can be low and rounded, or narrow and sharp. A ventral rim is always formed on top of a completed ventral rampart (excluding any hiatus).

Breakdown: Breakdown of the ventral margin is indicated by pitting and an erosion of the rim. The breakdown of the ventral margin must exceed 10 mm (either in one spot, or when two or more areas of erosion are combined) to be scored as present.

Notes:

- Occasionally a gap will remain in the superior half of the ventral margin at the completion of rampart formation (ventral hiatus). The ventral hiatus should not be confused with breakdown.
- Care must be taken to distinguish antemortem degeneration – that is, true breakdown – from postmortem damage. The latter, of course, can render the bone unscorable if it is extensive.

Examples:



PSVM Fig. 1: Location of the ventral margin.



PSVM-1: **Serrated**
(ID#:1125)



PSVM-2: **Rampart**

Lateral (a), and oblique (b) views of a ventral rampart in an early stage of ossification. Rampart formation often begins in the superior portion of the symphysis. (ID#:2724)



PSVM-3: Rampart
The rampart is forming. (ID#:2247)



PSVM-4: Rampart
The rampart is nearing completion. (ID#:2174)



SP-7: Breakdown
The rim along most of the ventral border is porous and irregular. (ID#:1571)



PSVM-5: Rampart
The rampart is essentially complete. (ID#:2015)



PSVM-6: Rim
More than 10mm of raised, regular rim extends along the ventral edge of the symphyseal face. The rim occurs on an otherwise billowed face. (ID#:2738)

Dorsal symphyseal margin [bilateral]

Location: ventral margin of the pubic symphysis

Scores: 0. serrated 1. flattened
 2. rim 3. breakdown

Serrated: Ridges and furrows typical of pronounced billowing extend uninterrupted into the edge of the bone.

Flattened: A well-defined area ≥ 10 mm long is present where the symphyseal face meets the dorsal margin, but ≥ 10 mm of rim is not present. Flattening usually starts in the superior part of the dorsal demiface; the remainder of the margin has the ridge and valley configuration typical of a youthful symphyseal face. This flattening eventually extends along the entire symphyseal face where it meets the dorsal margin. A small area at the inferior end of the dorsal margin occasionally retains an undulating appearance.

Rim: An elevated bony rim demarcates a flat or, infrequently, an irregular face. The rim projects slightly above the symphyseal face, and its crest can be blunt or sharp. The rim does not have to extend along the entire dorsal margin to be scored as present, but it must be ≥ 10 mm long. The 10 mm rule pertains to either a continuous rim or discontinuous segments that together sum to that length. A rim typically develops first along the superior part of the dorsal margin. It can, however, occur anywhere along the dorsal margin.

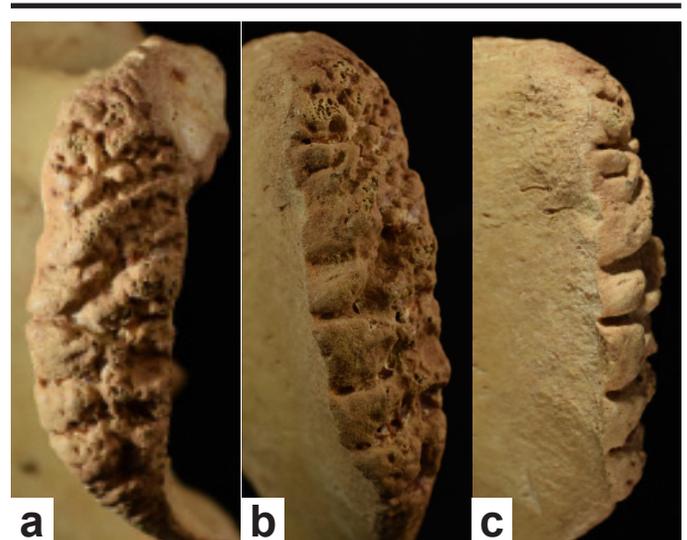
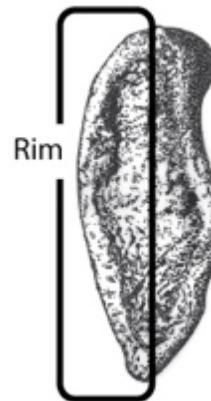
Breakdown: The dorsal margin where the rim is located shows evidence of breakdown when pitting and erosion of the edge of the pubic symphysis is ≥ 10 mm long. Breakdown must be ≥ 10 mm long either in one spot or when two or more areas of erosion are combined.

Notes:

- In females, dorsally located characteristics can be partly or entirely obscured by large postpartum, or parity, pits. Antemortem destruction attributable to large parity pits in females that undercuts the dorsal margin is not considered breakdown in the sense of the term as used here. In most cases, such specimens cannot be scored properly. When that occurs, the component is simply missing data.
- Care must be taken to differentiate antemortem degeneration of the margin from postmortem damage, which is of no concern.

Examples:

PSDM Fig. 1: Location of the dorsal margin.



PSDM-1: **Serrated**

Lateral (a), oblique (b), and posterior (c) views of a serrated dorsal margin. The billows cut deeply into the dorsal margin, which gives the appearance of a serrated knife blade. (ID#:2199)



PSDM-2: **Serrated**
(ID#:1913)



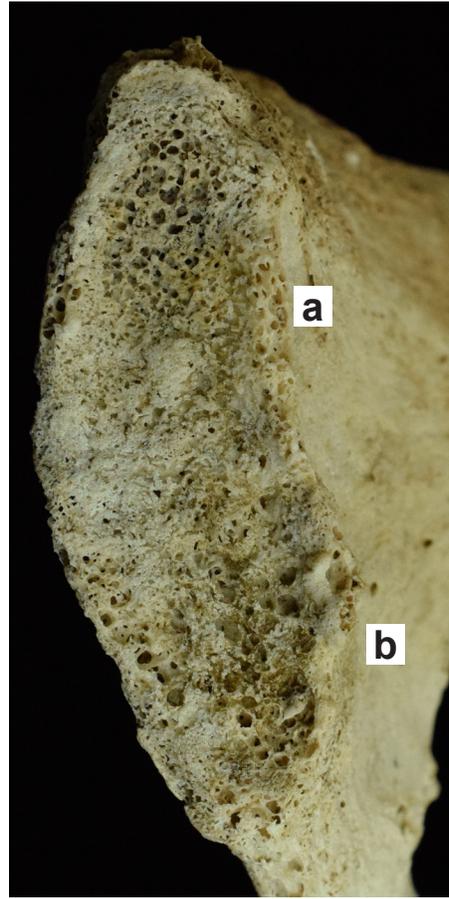
PSDM-3: **Flattened**
(ID#:1758)



PSDM-4: **Rim**
More than 10mm of raised, regular rim extends along the dorsal edge of the symphyseal face. The rim occurs on an otherwise billowed face.(ID#:2738)



PSDM-5: **Rim**
(ID#:2179)



PSDM-6:
Breakdown
The dorsal edge of this pubic face shows breakdown as both (a) porosity and (b) an irregular rim. The breakdown extends along essentially the entire length of the joint. (ID#:1571)