

## **Robert J. Terry Anatomical Skeletal Collection Postcranial Osteometric Database**

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This database is a set of postcranial osteometric data collected from the Robert J. Terry Anatomical Skeletal Collection. It is a compilation of measurements taken by Smithsonian Anthropology staff as well as measurements collected by visiting researchers who have provided their data. Elements included in this dataset include clavicles, scapulae, humeri, radii, ulnae, femora, tibiae, and fibulae. This dataset is considered a "work-in-progress" -- the goal of this project is to create an online database that is available to all researchers. It is intended to grow in size from the contributions by other researchers. The ultimate desire is to have a database that will contain metric observations for essentially all the Terry Collection individuals.

During the production of this present database, there needed to be verification of the osteometric measurements between observers. Metric values for each element that had comparable data were evaluated. All measurements differing greater than 7mm between observers and between the left and right side of an individual were revisited and generally, the element was then completely re-measured.

Most of the postcranial measurements follow protocols published in the 1994 *Standards for Data Collection from Human Skeletal Remains* (Standards); William Bass' 1995 *Human Osteology: A Laboratory and Field Manual*; and the National Museum of Natural History Laboratory Manual of the Repatriation Office (NMNH) and from the 1983 dissertation of Terry Zoebeck. A few measurements are different than described in these above three references; these are specifically noted in the measurement list below with an asterisk (\*). Measurements were collected using an osteometric board, fabric measuring tape, and Gneupel sliding and spreading calipers. Left and right elements are presented in the database and ultimately, the plan is to have both sides present in the database. Elements that showed damage or exhibited severe osteoarthritic lipping that hindered accurate measurements, trauma, or any type of gross pathological condition were not included. Reasons for absence of measurements in the database are noted in the remarks column.

Intra-observer error for D. DiMichele was evaluated by taking a subset of 30 individuals, and re-measuring seven (7) times within a random period. Correlation analysis provided significant results for each set of variables with confidence levels above 0.01. Maximum length had the highest correlation, at 0.99, while the lowest correlation was found in the sub-trochanteric AP and ML diameter with results of 0.96 and 0.97 respectively.

Inter-observer error was also tested between D. DiMichele and D.R. Hunt to guarantee consistency and repeatability.

### **MEASUREMENTS**

References to the measurement descriptions are noted in parentheses. During the data collection process it was clear that some measurements were difficult to follow and there was question of repeatability. Modifications to these measurements are noted, along with recommendations for changing certain measurements to be more consistent and repeatable. These problematic and/or modified measurements are marked with an asterisk (\*) and should be checked for the comments in the accompanying Data Collection Note. These notes contain recommendations for the proper measuring technique, as defined for this data set, and observations made during data collection.

### Clavicle:

**Maximum length** (ClavMaxLng): Osteometric board or sliding calipers. One end of the bone is placed against the stationary end of the board, and the movable end of the board is brought into contact with the opposite end of the clavicle. The clavicle is moved from side to side and up and down until the maximum length is obtained (Bass 1995:131; Standards:#35)

**A-P midshaft diameter\***(ClavAPDiaMid): Sliding calipers. Distance from the anterior to the posterior surface at midshaft. Determine the midpoint of the diaphysis on the osteometric board and mark it with a pencil. Then determine sagittal diameter. (Standards:#36)

**S-I midshaft diameter\*** (ClavSIDiaMid): Sliding calipers. Distance from the superior to the inferior surface at the midshaft. Taken perpendicular to the sagittal diameter. (Standards:#37)

**Maximum midshaft diameter\*** (MaxDiaMid): Sliding calipers. Maximum diameter at the midpoint of the clavicle. Using sliding calipers rotate until maximum diameter is obtained.

**Minimum midshaft diameter\*** (MinDiaMid): Sliding calipers. Minimum diameter at the midpoint of the clavicle. Using sliding calipers rotate until maximum diameter is obtained.

### Data Collection Notes:

- Issues affecting measurements appear to stem from improper siding of elements.
- Position clavicle is held affects SI and AP measurements.  
Measuring the maximum and minimum at midshaft gives more reliable repeatable numbers. The practice of taking AP and SI measurements are flawed depending on how the observer positions the bone during measurements. This is due to the morphological variability that can be observed in clavicles.

### Scapula:

**Maximum height** (ScapMxHt): Sliding calipers or osteometric board. The maximum straight-line distance from the superior to the inferior boarder. (Bass 1995:122; Standards:#38)

**Maximum breadth\*** (ScapMxBr): Spreading calipers. From the middle of the glenoid fossa to the end of the spinal axis on the vertebral border. (adapted from Bass 1995:122; adapted from Standards:#39)

**Spinous process length** (ScapSpineLng): Sliding calipers. From the end of the spinal axis on the vertebral border (same point as above) to the most distal point on the acromion process. (Bass 1995:122; NMNH:#18)

**Supra-spinous length** (ScapSuprSpnLng): Sliding calipers. From the end of the spinal canal axis on the vertebral border (same point as above) to the top of the anterior angle. (Bass 1995:122; NMNH:#19)

**Infra-spinous length** (ScapInfSpnLng): Sliding calipers. From the end of the spinal axis on the vertebral border to the tip of the posterior angle. (Bass 1995:122; NMNH:#20)

**Glenoid breadth\*** (ScapGlenBr): Sliding Calipers. Taken at a point just below the constriction of the ventral border. Measured across breadth of the glenoid cavity from the ventral to the dorsal margin. (Zoebeck 1983:#39)

**Glenoid height\*** (ScapGlenHt): Sliding calipers. Taken from the superior to the inferior margin of the glenoid cavity, being sure that the measurement is taken perpendicular to the glenoid breadth. (Bass 1995:125; Zoebeck 1983:#40)

**Inferior angle\*** (ScapGlenInfAng): Sliding calipers. Taken from the middle of the glenoid cavity to the inferior angle. (Bass 1995:122; Zoebeck 1983:#41; NMNH:#23)

Data Collection Note: Scapula glenoid inferior angle was taken from the center of the glenoid fossa. Maximum scapular breadth was taken from the middle of the glenoid fossa, opposed to the dorsal border to avoid arthritic changes – this is to keep the same measurement locations to derive scapular shape.

- Maximum scapular breadth has been taken from the middle of the glenoid fossa, not the dorsal border of the glenoid fossa in order to avoid arthritic changes.
- Scapula glenoid height and breadth should be taken by avoiding arthritic lipping surrounding the glenoid fossa. The measurement should focus on the articular surface and not the entire feature in order to arthritic changes that may cause mis-measuring.
- Scapula glenoid inferior angle should be taken from the center of the glenoid fossa.

### Humerus:

**Maximum length** (HumMaxLng): Osteometric board. Place the head against the fixed vertical of the board and adjust the movable upright to the distal end. Raise the bone slightly and move it up and down as well as from side to side until the maximum length is obtained. (Bass 1995:152; Standards:#40)

**Maximum proximal epicondylar breadth** (HumProxEpiBrL): Osteometric board. Widest distance across the upper epiphysis; being sure to include the greater tubercle. (Zoebeck 1983:#2; NMNH:#30)

**Maximum diameter at midshaft** (HumMxDiaMid): Sliding calipers. Maximum diameter at midshaft. Determine the midpoint of the diaphysis on the osteometric board and mark with a pencil. Record maximum diameter at whatever position in which it occurs. (Bass 1995:152; Standards:#43)

**Minimum diameter at midshaft** (HumMnDiaMid): Sliding calipers. Minimum diameter at midshaft. Determine the midpoint of the diaphysis on the osteometric board and mark with a pencil. Record minimum diameter at whatever position in which it occurs. (Bass 1995:152; Standards:#44)

**Maximum vertical head diameter\*** (HumMxVertHeadDia): Sliding calipers. In a superior-inferior direction, measure the greatest vertical diameter in superior-inferior axis of the head (Bass 1995:152; Standards:#42).

**Maximum distal epicondylar breadth** (HumDistEpiBr): Osteometric board or sliding calipers. Maximum distance across the epicondyles on the distal end. (Zoebeck 1983:#16; NMNH:#34)

**Least circumference** (HumLstCirc): Fabric Tape. This point is located in the lower one-third of the humeral diaphysis, where the shaft is the smallest at the reduction of the muscular ridges and crests, distal to the deltoid tuberosity. (Bass 1995:152; Zoebeck 1983:#45)

Data Collection Note:

- Maximum and minimum diameter at midshaft should be taken in whatever direction the maximum and minimum diameter occur.
- Vertical Head Diameter was taken by measuring the greatest vertical diameter with the sliding caliper shaft parallel to the humeral diaphysis and measuring the most superior-inferior edges of the head, excluding arthritic lipping.

Radius:

**Maximum length** (RadMxLng): Maximum length. Osteometric board. Measuring maximum length from the head to the tip of the styloid process. (Bass 1995:167; Standards:#45)

**Maximum head diameter** (RadMxHeadDia): Sliding calipers. From the edge of the articular surface to the opposite side. The bone is rotated until the maximum distance is obtained. (Zoebeck 1983:#17 - from Trotter and Gleser 1952; NMNH:#38)

**A-P diameter\*** (RadAPDia): Sliding calipers. Distance between anterior and posterior surfaces at midshaft. Determine midpoint of the diaphysis on the osteometric board and mark with a pencil. Measure the sagittal diameter. This measurement is almost always less than the medial-lateral diameter. (Standards:#46; NMNH:#39)

**M-L diameter\*** (RadMLDia): Sliding calipers. Distance between medial and lateral surfaces at midshaft. Perpendicular to anterior-posterior diameter. (Standards:#47; NMNH:#40)

**Maximum neck diameter\*** (RadNeckDia): Sliding calipers. Maximum diameter of the radial neck, taken between the inferior rim of the proximal articulation and above the biceps tubercle where the neck becomes mostly cylindrical. Using sliding calipers rotate around the radial neck until maximum diameter is obtained. (adapted from Zoebeck 1983:#46)

Data Collection Note:

- AP and ML diameter at midshaft should be changed to take the maximum and minimum diameter at midshaft or these measurements should be included as additional data collection points/positions.
- While the maximum and minimum diameter at midshaft are normally found in an AP and ML position, the definition should be changed to maximum and minimum diameter at midshaft to account for differing positions of the interosseous crest.

Ulna:

**Maximum length** (UlnaMxLng): Osteometric board. Maximum length is from the top of the olecranon process to the tip of the styloid process. (Bass 1995:171; Standards:#48)

**Physiological length** (UlnaPhysLng): Spreading calipers. The two measuring points are the deepest point on the longitudinal ridge running across the floor of the semilunar notch and the

deepest point of the distal surface of the “head”, not taking the groove between it and the styloid process. (Bass 1995:173; Standards:#51)

**Maximum breadth of the olecranon** (UlnaMxBrOlec): Sliding calipers. Measured from the medial and lateral margins of the olecranon process’ articular surface at its greatest breadth. (Zoebeck 1983:#18; NMNH:#45).

**Minimum breadth of the olecranon** (UlnaMnBrOlec): Sliding calipers. Measured from the medial and lateral margins of the olecranon process’ articular surface where the constriction on the medial margin becomes apparent. (Zoebeck 1983:#19; NMNH:#46).

**Maximum width of the olecranon** (UlnaMxWdthOlec): Sliding calipers. Measured in the antero-posterior direction from the anterior most portion of the olecranon process to the posterior most portion. (Zoebeck 1983:#20; NMNH:#47).

**A-P (Dorso-Volar) diameter\*** (UlnaAPDia): Sliding calipers. Maximum diameter of the diaphysis at the level of greatest crest development in anterior-posterior (dorso-volar) plane. (Standards:#49; NMNH:#50)

**M-L (Transverse) diameter\*** (UlnaMLDia): Sliding calipers. Distance between medial and lateral surfaces at the level of greatest crest development. Taken perpendicular to the anterior-posterior diameter. (Standards:#50; NMNH:#51)

**Least circumference** (UlnaLstCirc): Fabric Tape. This point is located slightly above the distal epiphysis, where the shaft becomes nearly cylindrical because of the reduction of the muscular ridges and crests. (Bass 1995:173; Standards:#52)

Data Collection Note: In the current data base all measurements of AP and ML diameter taken at the position of greatest crest development were taken as the maximum and minimum diameter. Minimum diameter should be taken at the same location and perpendicular to the maximum diameter.

- AP and ML diameter show discrepancies depending on how the observer holds the bone. Definition instructs to take measurement of AP and ML diameter at the position of greatest crest development. However it appears that observers measure the maximum crest development regardless of whether the bone is positioned in correct anatomical position. Failure to position the bone anatomically does not allow the observer to correctly measure the AP and ML diameter at greatest crest development and increases interobserver error among individuals who measure maximum and minimum diameter versus those who measure the bone in anatomical position at this landmark.
  - i. A solution to create more consistency in this measurement would be to measure the diameter of maximum crest development wherever it should occur and subsequently take an accompanying measurement perpendicular to the position of maximum crest development.
  - ii. An alternative method would be to simply take the maximum and minimum measurement at midshaft or at the position of maximum crest development.
- Least circumference is variable between observers and is not an accurate assessment of size.

### **Femur:**

**Maximum length** (FemMxLng): Osteometric board. Distance from the most superior point on the head of the femur to the most inferior point on the distal condyles. Place the medial condyle

against the fixed vertical end board while applying the movable upright to the femoral head. (Bass 1995:223; Standards:#60)

**Bicondylar length** (FemBiConLng): Osteometric board. Distance from the most superior point on the head to a plane drawn along the inferior surfaces of the distal condyles. Place both distal condyles against the fixed vertical end board with applying the movable upright to the femoral head. (Bass 1995:224; Standards:#61)

**Trochanteric length** (FemTrocLng): Osteometric board. Greatest distance between superior edge of the greater trochanter and the lateral condyle. (Zoebeck 1983:#7, from Martin and Saller 1957; NMNH:#64)

**A-P (sagittal) subtrochanteric diameter\*** (FemSubTrAPDia): Sliding Calipers. Distance between anterior and posterior surfaces at the proximal end of the diaphysis, measured perpendicular to the medial-lateral diameter. Location below the third trochanter ridge. Be certain that the two subtrochanteric diameters are recorded perpendicular to one another. Gluteal lines and/or tuberosities should be avoided. (adapted from Bass 1995:225; adapted from Standards:#64; Zoebeck 1983:#23)

**M-L (transverse) subtrochanteric diameter\*** (FemSubTrMLDia): Sliding calipers. Distance between medial and lateral surfaces of the proximal end of the diaphysis at the point of its greatest lateral expansion below the base of the lesser trochanter. Be certain that the two subtrochanteric diameters are recorded perpendicular to one another. (adapted from Bass 1995:225; adapted from Standards:#65; Zoebeck 1983:#24)

**A-P (sagittal) midshaft diameter** (FemAPDiaMid): Sliding calipers. Distance between anterior and posterior surfaces measured at the midpoint of the diaphysis, at the highest elevation of linea aspera. The sagittal diameter should be measured perpendicular to the anterior bone surface. (Bass 1995:224; Standards:#66)

**M-L (transverse) midshaft diameter** (FemMLDiaMid): Sliding calipers. Distance between the medial and lateral surfaces at Midshaft, measured perpendicular to the anterior-posterior diameter. (Bass 1995:224; Standards:#67)

**Maximum vertical head diameter** (FemHeadSIDia): Sliding calipers. The greatest superior-inferior diameter perpendicular to the plane passing through the axis of the neck. (Zoebeck 1983:#27, from Martin and Saller 1957; Pearson 1917; NMNH:#69)

**Maximum horizontal (transverse) head diameter** (FemHeadHzDia): Sliding calipers. The maximum diameter, measured perpendicular to the vertical head diameter. (Zoebeck 1983:#28, from Martin and Saller 1957)

**A-P lateral condyle diameter** (FemAPLatCond): Sliding calipers. The projected distance between the most posterior point on the lateral condyle and lip of the patellar surface taken perpendicular to the axis of the shaft. (Zoebeck 1983:#29, from Montagu 1960; NMNH:#70; NMNH:#71)

**A-P medial condyle diameter** (FemAPMedCond): Sliding calipers. The projected distance between the most posterior point on the medial condyle and the lip of the patellar surface taken perpendicular to the axis of the shaft. (Zoebeck 1983:#30, from Montagu 1960; NMNH:#72)

**Epicondylar breadth** (FemEpicBr): Osteometric board or sliding calipers. Greatest breadth of the most projecting points of the epicondyles, parallel to the infracondylar plane (Standards:#62; Zoebeck 1983:#43, from Martin and Saller 1957; NMNH:#73)

**Bicondylar breadth** (FemBiConBr): Sliding calipers. Greatest breadth across the condyles (transverse condylar breadth) taken at a point in the middle of each condyle (posteriorly). (Zoebeck 1983:#44, from Hrdlička 1939; Pearson 1917; NMNH:#74)

**Vertical neck diameter** (FemNeckDia): Sliding calipers. Minimum vertical diameter of the femoral neck. Placing the calipers around the femoral neck, measurement should be recorded at the point of minimum diameter, perpendicular to midline of femoral neck (femoral neck angle). (Zoebeck 1983:#48; NMNH:#75)

**Midshaft circumference** (FemCircMid): Fabric Tape. Circumference measured at the level of the midshaft diameters. If the linea aspera exhibits a strong projection which is not evenly expressed across a large portion of the diaphysis, then this measurement is recorded approximately 10mm above the midshaft. (Bass 1995:225; Standards:#68)

Data Collection Note: Subtrochanteric diameter was taken holding the femur in an anterior and posterior position. It was not taken looking for the maximum and minimum subtrochanteric diameter.

- Subtrochanteric AP and ML diameter and the diameter of the femoral neck appear to contain the most discrepancies due to observers that measuring the platymetric indices of femora. Differences in this measurement arise from observers using the Bass' *Human Osteology Field Manual* (pp.225, Nos. 8 & 9, as opposed to the *Standards for Data Collection* manual (pp.82, Nos. 64 &65).

### Tibia:

**Condylar-malleolar length** (CondMallNg): Osteometric board. Distance from the superior articular surface of the lateral condyle to the inferior tip of the medial malleolus. Place the tibia on the board, resting on its posterior surface with the longitudinal axis parallel to the instrument. Place the lip of the medial malleolus on the vertical endboard and press the movable upright against the proximal articular surface of the lateral condyle. (Bass 1995:245; Standards:#69)

**Maximum breadth proximal epiphysis\*** (MxBrProxEpi): Osteometric board or sliding calipers. Maximum distance between the two most laterally projecting points on the medial and lateral condyles of the proximal articular region (epiphysis). Tibia diaphysis should parallel the uprights of the osteometric board. (Standards:#70; Zoebeck 1983:#9)

**Maximum breadth distal epiphysis** (MxBrDistEpi): Osteometric board or sliding calipers. Maximum distance between the two most laterally projecting points on the medial malleolus and the lateral surface of the distal articular region (epiphysis). (Standards:#71; Zoebeck 1983:#10)

**A-P diameter at nutrient foramen\*** (TibAPDia): Sliding calipers. Distance between the anterior crest and the posterior surface at the level of the nutrient foramen. (Bass 1995:245; Standards:#72; Zoebeck 1983:#31)

**M-L diameter at nutrient foramen\*** (TibMLDia): Sliding calipers. Straight line distance of the medial margin from the interosseous crest at the level of the nutrient foramen (Bass 1995:245; Standards:#73; Zoebeck 1983:#32)

**Nutrient foramen position\*** (TibNutPos): Sliding calipers. Measured from the most superior point on the intercondylar eminence to the most distal point on the nutrient foramen. (Zoebeck 1983:#33; NMNH:#83)

**Circumference at nutrient foramen** (TibCirc): Fabric tape. Circumference measured at the level of the nutrient foramen. (Bass 1995:245; Standards:#74)

Data Collection Note: In the current data base, all measurements of AP and ML diameter at the nutrient foramen were performed measuring the maximum diameter and a minimum diameter.

- Varying nutrient foramen position makes for inaccurate or inconsistent AP and ML measurements
  - i. Tibial AP and ML diameter should be replaced with a maximum and minimum measurement performed at midshaft or a maximum or minimum measurement performed at the nutrient foramen (as done by Zoebeck 1983) if it is important to continue to include these measurements.
  - ii. The nutrient foramen is not a reliable landmark due to the varying position along the shaft, thus giving diameter measurements that have not been shown to be unique to any demographic group.
    1. This measurement tells more about the specific bone rather than it does a population. Future research should examine variation in tibial nutrient foramen positions.

### **Fibula:**

**Maximum length** (FibMxLng): Osteometric board. Maximum distance between the most superior point on the fibula head and the most inferior point on the lateral malleolus. (Bass 1995:257; Standards:#75)

**Maximum midshaft diameter** (FibMxDiaMid): Sliding calipers. Maximum diameter at midshaft. Maximum diameter is most commonly located between the anterior and lateral crests. Find the midpoint of the diaphysis using the osteometric board and mark with a pencil. Place the diaphysis of the bone between the two branches of the calipers while turning the bone to obtain the maximum diameter. (Standards:#76; NMNH:#87)

Data Collection Note: Improper siding of this element by other researchers became evident when in several cases one side was too damaged to measure accurately.

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