

TECHNICAL NOTE

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A Method for Siding and Sequencing Human Ribs

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ABSTRACT: Siding and sequencing (that is, putting in anatomical order) human ribs are essential to the proper examination and documentation of injuries to the chest. The paucity of information regarding sequencing nonfleshed human ribs makes it particularly difficult for physical anthropologists and medicolegal authorities to differentiate the midthoracic ribs. It was found that ribs could be accurately sequenced without the aid of a comparative skeleton using such features as maximum (relative) rib length, the size and shape of the articular facets, the distance between the articular facets and rib angle, and the height of the rib heads relative to one another.

KEYWORDS: physical anthropology, human rib, osteology, forensic anthropology

One of the most difficult tasks for the physical/forensic anthropologist is determining the sequence of human ribs devoid of soft tissue. Even the most commonly cited or referenced anatomy and human osteology textbooks devote little attention to the identification and distinguishing features of other than the first, second, and tenth through twelfth ribs [1-5]. If the ribs are for the most part complete and undamaged, the most cited rule of thumb for sequencing (that is, placing in anatomical order) ribs is ". . . the ribs increase in length from the first through the seventh rib and decrease from the eighth through the twelfth" [1]. These authors also report that ribs one, eleven and twelve have single articular facets and ribs two through nine and occasionally rib ten, have double facets.

Correctly siding and sequencing human ribs are essential to any physical/forensic anthropology and medicolegal examination. Although osteologists skilled in the identification of human bones can easily determine whether a rib is from the right or left side of the body, the relative lack of systematic methods for differentiating the midthoracic ribs (that is, ribs four through ten) makes it difficult to identify them. Experience has shown that sequencing fragmentary ribs is an even more difficult task. The importance and purpose of placing ribs in their proper anatomical order are to: 1) determine the number of individuals represented, 2) match stab marks and gunshot wounds in clothing with the corresponding underlying ribs, 3) provide information on the minimum number

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of puncture wounds (that is, stabs and gunshots) to the thoracic region, 4) to apply techniques for establishing age-at-death using cartilaginous and osseous changes in the sternal end of the ribs [6] and, 5) match premortem broken ribs with dry bone specimens to establish or corroborate a positive personal identification based on premortem medical records. The following information provides the reader with a method for determining the side and sequence of human ribs.

Materials and Methods

The information provided here was obtained through examination of adult cadaver and dry bone specimens at the Department of Anthropology, University of Tennessee, Knoxville, and the Department of Anthropology, National Museum of Natural History, Washington, D.C. The individuals studied consisted of adults of all ages that were either autopsied or examined for the purpose of establishing a positive identification (that is, forensic anthropology cases) for police and federal agencies. The morphology of the ribs and their attachments to the spine (that is, costal facets) were observed *in situ* before being dissected. In many instances the ribs were attached to the vertebrae by mummified soft tissue such as ligaments. For comparison, the technique was then successfully applied (that is, tested for consistency) to twenty adults in the Terry Anatomical Collection at the Smithsonian Institution. Although there was shape variability in some ribs (that is, elderly ribs may lose their curvature and resemble a shepherd's crook), the majority of ribs conformed to the features given in this report.

Siding Human Ribs

The human body typically has 24 ribs, arranged in two rows of 12 on either side of the chest (Fig. 1). The number of ribs may vary from 23 (that is, absence of a rib) to 26 (that is, presence of accessory ribs). Occasionally, individuals may have an accessory rib for attachment to one or more of the cervical (that is, neck) vertebrae. More rarely, one of the lumbar transverse processes, which resembles a small rib and is sometimes referred to as a lumbar rib, remains unattached throughout an individual's life.

The external (that is, outer or skin side) surface of a rib is convex and smooth, and the internal (that is, lung side) surface is somewhat irregular. Ribs 3 through 10 show similar features and are usually referred to as typical ribs while ribs 1, 2 and 11 and 12

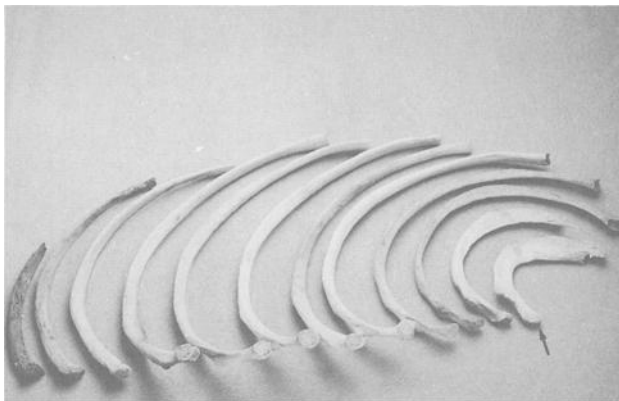


FIG. 1—*Superior view of the left ribs of an adult male (arrow indicates the first, uppermost, rib).*

are atypical. A typical rib consists of a head with costal facet(s), neck, crest of neck (ribs 4 through 9), articular facet and tubercle (for articulation with the transverse process of the vertebra), angle (where the rib not only bends, but twists), costal groove for the transmission of nerves and vessels, and shaft or body (Fig. 2). The head attaches to the vertebra and the cupped end to the sternum via costal cartilage. The superior edge of a rib is blunt and rounded, and the inferior edge is sharp. To orient a rib:

1. Place the rib on a table in front of you with the rib head pointed toward you and the cupped end pointed away from you.
2. Ensure that the sharp edge is down (touching the table) and the costal groove is “inside” the convexity of the rib (the costal groove is deepest and most prominent nearest the spine and gets shallower as it approaches the sternal end). When in this position, the convexity of the rib bends (that is, points) to the correct side.

Determining the Sequence of Human Ribs

After siding the ribs, lay them out in approximate anatomical order beginning with the smallest “C-shaped” rib (that is, first rib) and ending with the shortest, straightest rib (that is, twelfth rib) (Fig. 1). Referring to Fig. 2, note that the heads of ribs 1, 2, 11, and 12 touch the table while the heads of ribs 3 through 10 are raised. Also note that the distance between the table and the heads of ribs 3 through 7 gradually increases while the distance for ribs 8 through 10 decreases, often resembling a bell-shaped curve. In most cases the head of rib 7 will form the “apex” of the bell-shaped curve by projecting above the other ribs. In some individuals the heads of ribs 7, 8 and 9 will be approximately equal in height.

Another trait useful in sequencing ribs is the relative size and shape of the heads. The heads of ribs 1 through 4 are circular or ovoidal (Fig. 3). The heads of ribs 5 through 7 are approximately equal in size and usually assume the shape of a figure-eight. Generally, the inferior costal facet (that is, demifacet) of ribs 8 and 9 is smaller than the superior costal facet. Ribs 11 and 12 each have a single, circular-shaped costal facet. Six other traits are the following:

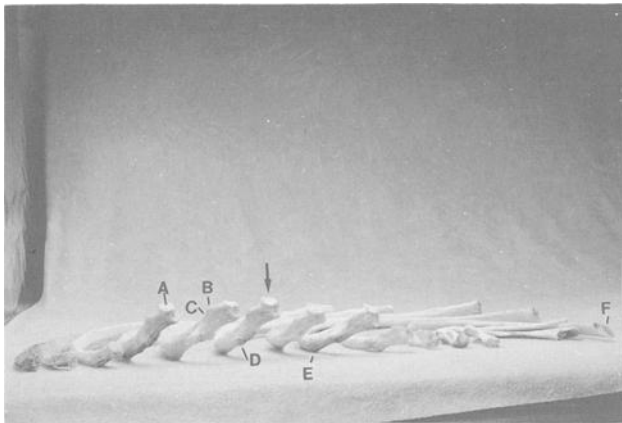


FIG. 2—Medial view of the left ribs (arrow points to rib 7) with special reference to the relative heights and shapes of the heads. A = costal facet (head); B = crest of necks; C = neck; D = articular facet and tubercle; E = angle; F = sternal end.



FIG. 3—Differences in the shapes of the vertebral articular facets (arrow indicates left rib 1).

1. The shafts of ribs 3 through 6 are thick and rounded (that is, “squared”) mediolaterally (that is, internal to external surface; those of ribs 7 through 12 are narrower mediolaterally (that is, more “bladelike”), usually with more prominent angles.

2. The distance from the tubercle near the articular facet to the angle (the roughened oblique line on the external rib surface for attachment of the ilio-costalis muscle) increases from ribs 4 through 11 (ribs 11 and 12 lack a tubercle and rib 12 usually loses all trace of the ilio-costalis line) (Fig. 4). Line up the articular facet tubercles by “stacking” the ribs on top of one another and comparing the relative position of the roughened line. This distance can also be obtained by measuring the length from the inferior costal facet (vertebral end) to the inferior point of the angle, usually visible as a small projection of bone on the inferior margin of the rib shaft. This feature proved to be the quickest and most accurate method for distinguishing complete and fragmentary ribs.

3. The costal groove is most prominent (that is, deep) on ribs 5, 6 and 7.

4. Ribs 6, 7 and 8 are most similar in size and shape and are therefore the most difficult ribs to sequence. However, rib 7 will be the longest, followed by ribs 6 and 8 (the shortest of the three). If the rib is fragmentary, determine its sequence using the position of the ilio-costalis line.

5. The sternal ends of ribs 11 and 12 taper almost to a point.

6. The neck crest of rib 4 may or may not be separated from the single superior costal facet. Ribs 3 through 8 have a prominent neck crest that is separated from the upper margin of superior costal facet by a mild concavity. Rib 10 usually lacks a neck crest.

Conclusions

Adult human ribs, regardless of sex and age, can be accurately sided and sequenced using a simple visual method of aligning the ribs side by side on a table top. Once sequenced, the ribs can be examined for evidence of premortem and perimortem trauma and compared with tears in the decedent’s clothing. By using this method it is possible to determine the anatomical order of human ribs for comparison with premortem x-rays, as well as to determine which ribs exhibit perimortem injuries based on dry bone specimens.

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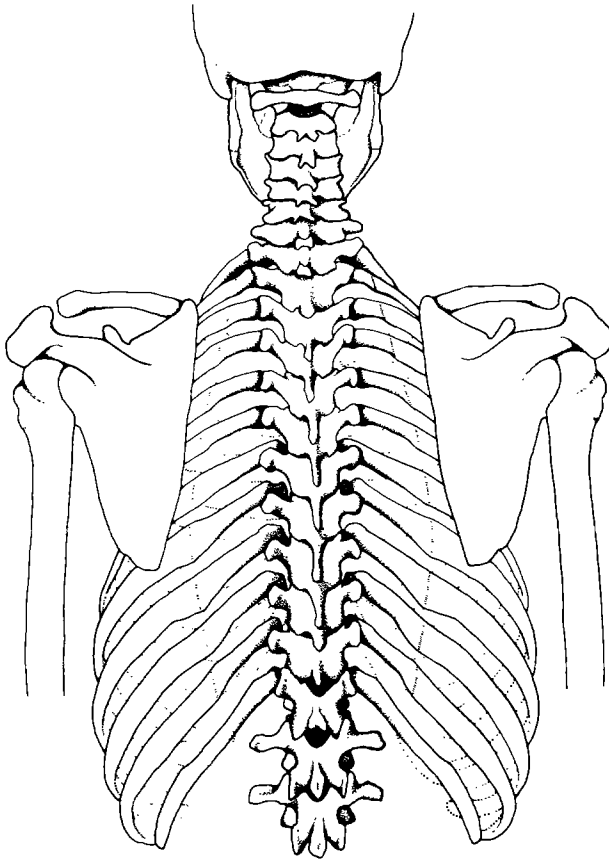


FIG. 4—Differences in the position and distance between the tubercle and angle (roughened oblique areas) of the ribs.

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