

APPENDIX K

DETERMINATION OF AGE FROM BONE MORPHOLOGY

K-1. General

Many technical and anatomical studies have been conducted to improve methods and techniques of identifying deceased personnel. One study made of the skeletal age changes in the American male was based on the skeletal observation of 450 deceased American servicemen and the research conducted on them. As a result, a system of scoring was established for recording different stages of bone development in relation to the specific age range for the remains. To determine age accurately, more than one bone was used in the scoring. A similar procedure was established for obtaining a total score for bone development throughout the entire skeleton.¹

K-2. Anatomical Study

As a result of anatomical study, it was determined that the innominate, or hip, bone would serve as the best indicator of estimated age. The innominate bone, when mature, is one of a pair of large irregularly shaped bones which, with the sacrum, make up the pelvis. Before maturity, each innominate is composed of three main parts— ilium, ischium, and pubis² — and several epiphyses.³ At 17 years of age, the three main elements of the innominate are almost completely united, and three epiphyses — the iliac crest, ischial tuberosity, and ramus— are ununited. The symphyseal face⁴ of the pubis undergoes a succession of changes in structure and shape. These changes in the symphyseal face of the pubis occur later in adult life than do changes in other parts of the skeleton. The separate components of each symphyseal face as well as the transformation by stages occurring in the symphyseal face of the pubic bone are evident. Visual recognition of the stages may be expressed in a formula to provide the basis for estimating the age for the remains being examined. The developmental stages are recorded by using a formula consisting of three

component parts— the dorsal plateau, the ventral rampart, and the symphyseal rim. Since the components develop gradually, it is necessary to number the developmental stages of all components from one to five. In addition, a preliminary stage (0), denoting absence of the feature in question, precedes each set of stages. The three symphyseal components and their development stages are defined as follows:

a. *Component Z, Dorsal Plateau.* In the early age groups (up to 17-18 years), the symphyseal surface is covered by a pattern of transverse ridges and grooves. With progressing age, a dorsal margin appears that eventually outlines the entire dorsal half (demiface⁵) of the surface. Then, through the interacting processes of resorption and fill-in, the ridge-groove pattern disappears as the grooves near the dorsal margin begin to fill in with finely textured bone, and the ridges begin to show resorption. This gives the demiface a flat, platformlike appearance and, for this reason, the component is named "dorsal plateau." The six developmental stages of component I are described below; the five active stages are shown in figure K-1.

0. A dorsal margin absent.
1. A slight margin formation first appears in the middle third of the dorsal border.
2. The dorsal margin extends along the entire dorsal border.
3. The filling in or grooves and a resorption of the ridges begins forming a plateau in the middle third of the dorsal demiface.
4. The plateau, still exhibiting traces of billowing, extends over most of the dorsal demiface.
5. The billowing disappears completely, and the surface of the entire demiface becomes flat and slightly granular in texture.

¹For complete information on findings for individual bones and predicted age based on a complete analysis of all bones of the skeletal remains, the reader is referred to "Skeletal Age Changes in Young American Males" by Dr. T. D. Stewart and Dr. T. W. McKern, Quartermaster Research and Development Center, Environmental Protection Division, Technical Report EP-45, May 1957.

²Pubis: The two pelvic bones.

³Epiphysis: A piece of bone separated from a long bone in early life by cartilage but later becoming part of the larger bone.

⁴Symphyseal face: The line of junction or fusion between bones originally distinct.

⁵Since the changes in components I and II are confined to the dorsal and ventral halved of the symphyseal face, the term "demiface" (dorsal and ventral) is used when referring to these components.

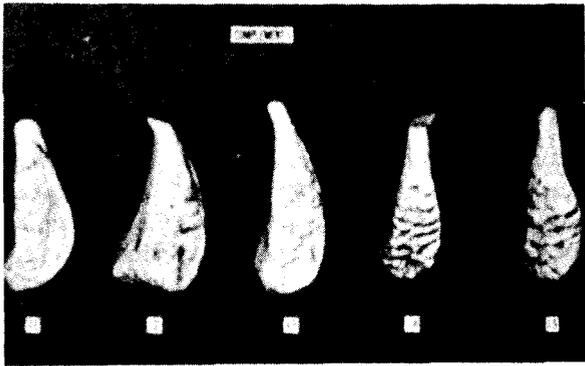


Figure K-1. The five active stages of component I.

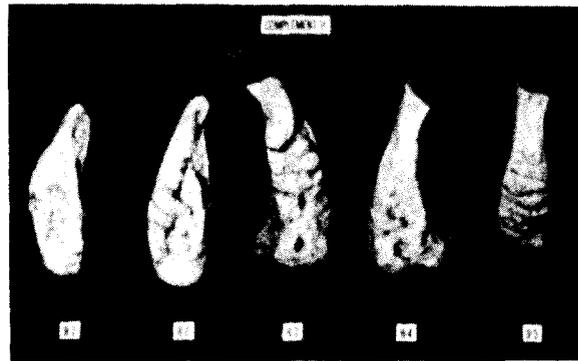


Figure K-2. The five active stages of component II.

b. Component II, Ventral Rampart. Early in the development of component I, the ventral demiface has a porous appearance and is beveled. Over this porous, beveled surface, an elongated growth, or rampart, forms, produced by ossification extending from the upper and lower extremities of the bone. At times, independent ossicles (small bones) along the line of future ventral margin aid the formation of the rampart. The pattern is variable, however, and the rampart may remain incomplete even in older age groups, or it may bridge only certain portions of the beveled surface. The gap usually occurs in the middle two-thirds of the ventral border. The six developmental stages of component I are listed below; the five active stages are shown in figure K-2.

0. The ventral beveling is absent.
1. The ventral beveling is present only at the superior extremity of the ventral border.
2. The bevel extends inferiorly along the ventral border.
3. Bony extensions from either or both extremities indicate the beginning of the ventral rampart.
4. The rampart is extensive, but gaps are still evident along the earlier ventral border, especially in the upper two-thirds.
5. The rampart is complete.

c. Component III, Symphyseal Rim. The symphyseal articular face is in final stages of development when a distinct and elevated rim forms around the level face of the bone. At the same time, the bony texture of the face begins to change from granular to finely grained and smooth. Traces of the ridge-groove pattern may still be present in the lower third of the dorsal demiface. However, determining whether the ridge-groove pattern is present or whether it only appears to be present may be difficult, since the regular wavy surface of the smooth bone sometimes looks like traces of the ridges and grooves. After the symphyseal rim is formed, minor and infrequent changes may continue for a while. Finally, the rim wears down through resorption, and a smooth surface extends to the margins. As the face levels off, erosion and erratic ossification take place, and the margins may become lipped. The six developmental stages of component II are described below; the five active stages are shown in figure K-3.

0. The symphyseal rim is absent.
1. A partial dorsal rim is present, usually at the superior end of the dorsal margin. The rim is round and smooth in texture and elevated above the symphyseal face.
2. The dorsal rim is complete, and the ventral

rim is beginning to form. There is no absolute site at which formation begins.

3. The symphyseal rim is complete. The inclosed symphyseal surface is finely grained in texture and irregular (wavy) in appearance.

4. The rim begins to break down. The face becomes smooth and flat, and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

5. A further breakdown of the rim, especially along the superior ventral edge, and refinement of the symphyseal face take place. Also, disintegration and erratic ossification occur along the ventral rim.

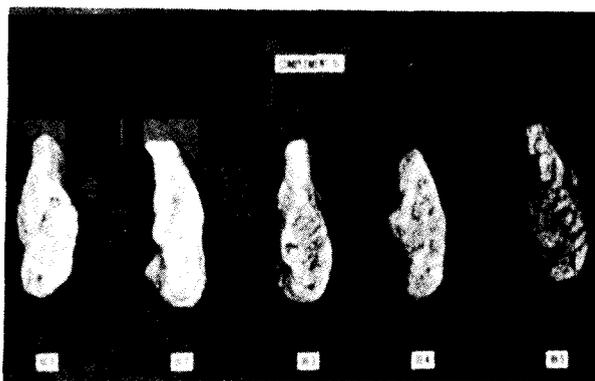


Figure K-3. The five active stages of component III.

K-3. Analysis of Symphysis

a. *General.* Sets of plastic model symphyseal casts have been fabricated to aid in recognizing symphyseal features. The models represent the three components and their five active stages of development (fig K-1, K-2, and K-3). By comparing paired pubic symphyses of skeletal remains with these plastic models, the estimated age may be determined.

b. *Symphyseal Formula.* Specific features within each component must be carefully selected to match the symphysis being observed. The selections make up the symphyseal formula. For example, the formula 3-3-0 indicates that the symphysis being observed was in the third stage of the dorsal plateau component (component I), in the third stage of the ventral rampart component (component II), and that metamorphosis of the symphyseal rim (component III) had not begun. The plastic models may be used in estimating the skeletal age of American males 17 to 40 years of age. The component and stage numbers for all models are stamped on the base of the model. Instructions for using the models are given below:

(1) View each model with the superior and inferior extremities in the vertical axis. Elements of

the symphyseal components of the pubic bone are shown in figure K-4. All models represent left symphyses except 1, 2, 4, and 5 of component II.

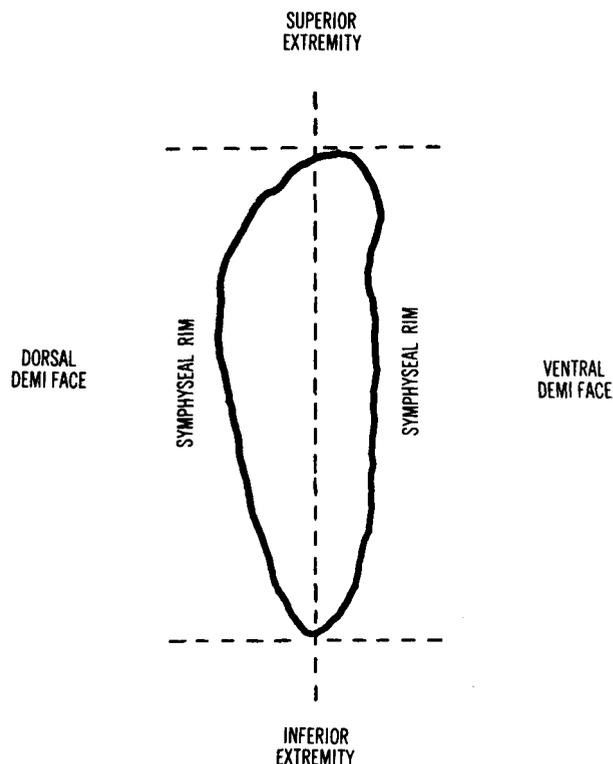


Figure K-4. Elements of the symphyseal components of the pubic bone.

(2) Place the symphyseal face of the pubic bone for age determination in similar relation to the plastic models.

(3) Compare the dorsal demifaces (component 1) and select the model stage that is most like the unknown demiface. If symphyseal change has not begun, score the component as 0. When the appropriate stage has been selected, score the component by reading the stage number (1 through 5) from the base of the model. Component I is for the dorsal demiface only.

(4) Follow the same procedures as above for the ventral demiface (component II).

(5) Compare the symphyseal rim and inclosed surface (component III) of the unknown symphysis with the model component stages. If the rim has not begun to form, score the component as 0. Match and select the appropriate stage and score as before.

(6) Add the scores for the three components and find the estimated age for that total score by referring to table K-1.

¹For more detailed information, the reader is referred to McKern and Stewart. op cit.

Table K-1. Calculated Mean Ages Based on Total Component Scores

<i>Total score</i>	<i>Calculated mean age</i>	<i>Standard deviation</i>	<i>Observed age range</i>
0	17.29	.49	-17
1-2	19.04	.79	17-20
3	19.79	.85	18-21
4-5	20.84	1.13	18-23
6-7	22.42	.99	20-24
8-9	24.14	1.93	22-28
10	26.05	1.87	23-28
11-13	29.18	3.33	23-39
14	35.84	3.89	29+
15	41.00	6.22	36+
