Forensic Anthropology Population Data

Determining the age at death of females in the Chinese Han population: Using quantitative variables and statistical analysis from pubic bones

Xi-ping Chen [a,1], Zhong-yao Zhang [b,2], Guang-you Zhu [c], Lu-yang Tao [a,*]

[a] Department of Forensic Science, Medical School of Soochow University, Suzhou, 215123 Jiangsu, PR China
[b] Institute of Crime Scene Investigations of Shenyang, Shenyang, 110002 Liaoning, PR China
[c] Institute of Forensic Science, Ministry of Justice, PR China, Shanghai 200063, PR China

ABSTRACT

Determining the age at death of females by skeletal features is extremely difficult and important, both in forensics and in physical anthropology. Our previous study of male pubic symphysis suggests that the indicators of morphological changes provide the best results for personal age identification. The indicators that help deduce of the age of females was approximately the same as males except for two specific indicators, which are bone density of the symphysial surface and viz. Viz are ridges and furrows on the symphysial surface, ossific nodules, lower extremities, ventral and ridge of the rampart, dorsal margin, ventral beveling and general macroscopic changes on the symphysial surface. Samples were drawn from 338 female individuals. The study procedures are as follows: Firstly, we examined the morphological features of pubic symphysis using the criteria similar to Hanihara's, Gilbert–McKern and Suchey–Brooks's methods. Secondly, we evaluated each stage with an appropriate score. Thirdly, we deduced four equations to assess the morphological features of the ages of females by statistic analysis. The results were discussed by comparing with Hanihara's, Gilbert–McKern and Suchey–Brooks's methods. The results were consistent and the developing methods for determining the age of death of females were produced.

© 2011 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Identification of human remains is necessary and difficult for forensic and physical anthropology. Among the various methods, skeletal estimation can lead to reliable findings of personal identifications such as, age, sex, race, and stature of the individual [1]. The morphological changes of pubic symphysis have been widely accepted as an accurate method for estimating adult skeletal age [2]. Todd (1920), as a pioneer, first outlined the morphological 10-stage method for estimating the skeletal age based on the male pubic symphysis. Since then, there have been many studies that have undertaken the approach to estimate skeletal age and many modified methods have been reported. The three-component system for symphysial aging is devised by McKern and Stewart for males and modified by Gilbert and McKern for females [3]. Hanihara first assessed the pubic age by scoring each morphological stage of the symphysis by its surface,

on the Japanese population [4]. Suchey–Brooks (1990) outlined a 6-stage method by comparing it with traditional Todd, McKern, and Stewart methods [5,6]. Our previous study had founded that the Hanihara and Suchey–Brooks' method showed a high accuracy for estimating the age at death of males. Recently, numerous physical anthropologists have pointed out the need for regional standards for estimating age in various populations [7], as well as the morphological standards for age at death assessment of male adult skeletons since they were not directly applicable to females [8]. We assumed that the Hanihara, Gilbert–McKern and Suchey–Brooks' methods would be highly efficient in estimating the age at death in the Chinese female population. In this study, we had a larger female sample size by increasing the age limits previously set by Hanihara and placed them into six different age phases.

In addition, we considered that the stage transitions of chronological aging of pubic symphysis are playing an important role in the estimation of age at death. Furthermore, the secondary sex characteristic of females might result in the specific changes on their pubic symphysis [9,10]. The aim of this study was to set up an integral and specific methodological criteria for determining the age at death from pubic symphysis for the Chinese female population. We are not only using similar morphological indicators from the methods of Hanihara, Gilbert–McKern's and

Table 1
Distribution of ages at death in the samples.

	Ages						Total
	14–20	21–30	31–40	41–50	51–60	61–70	
Collection numbers	45	81	72	50	46	44	338
Variance numbers	3	3	2	3	2	1	14
Study sample numbers	42	78	70	47	44	43	324

The samples were drawn from 338 female individuals. 14 pairs of misshapen were excluded from the samples and had been collected for the further study.

Suchey–Brooks' but are also modifying and improving their methods as well.

2. Materials and methods

2.1. Collection of pubic bones

Three hundred and thirty-eight pairs of female pubic bones were collected at forensic autopsies from the Chinese Han population. The collection of all samples was permitted by lineal relatives before its removal from the autopsy. Samples were obtained with the same procedure as our previous study with males pubic symphyses [11].

2.2. Sample distribution of ages at death

The female pubic samples were recorded with known age, ranging from 14 to 70 years. The distribution of ages at death of samples and variance is listed in Table 1.

2.3. Examinations of pubic symphyses

Three examiners examined the same eight indictors and features as in our previous study of male pubic symphyses [11] on these 338 pairs of female samples. All examiners were in compliance with the same rules as our previous study [11].

The indicator of the ridge of rampart, which is known as the unique ventral arc in the female population for age determination [9], was outlined in the study and examined according to the similar features as Gilbert–McKern's and Suchey–Brooks'.

2.4. Nine morphological indicators of pubic symphysis

From our previous study of male pubic bones, nine morphological indicators of pubic symphysis were used for the estimation of female age in Chinese Han population. The ridge of the pubic tubercle was excluded from the study because only a bone thorn is visible, unlike the obvious tubercle observed in some females before adolescence. Excluding this indicator, the ridge of rampart, which is known as a specific secondary sex characteristic for the female population was outlined.

A. Ridges and furrows on the symphysial surface: The ridges and furrows on the symphysial surface vary from gender and changes with increasing age. Female ridges usually disappear later than that of males. However a few observed early disappearance of ridges might have some relationship with procreation. Ridges and furrows on the female symphysial surface were classified into five stages and scored 0–4.
- Score 0: Ridges and furrows alternate distinctly, ridges high and sharp, furrows deep with multi-holes;
- Score 1: Ridges become transversal and high; furrows tend to have fewer holes;
- Score 2: The bone substance has a granular look with low, blunt ridges and shallow furrows;
- Score 3: The surface becomes flat, ridges and furrows almost disappear;
- Score 4: Disappearance of ridges and furrows, surface becomes pitted and eroded (Fig. 1).

B. Ossific nodule: Known as the ossific center of the symphysial surface. The process of development of the female ossific nodule is similar to that of males. The female ossific nodule was classified and scored as follows.
- Score 0: No appearance of ossific nodule;
- Score 1: Appearance of ossific nodule;
- Score 2: Fusion and disappearance of ossific nodule (Fig. 2).

C. Lower extremity of the symphysial surface: Lower extremity of female symphysial surface developed later than that of males because of the later disappearance of the ridges on the symphysial surface. The substance within the V·· angle is flat and smooth rather than sunken in males. Four stages were scored.
- Score 0: No appearance of lower extremity;
- Score 1: Appearance of the dividing line between the symphysial surface and the inferior ramus of the pubis;
- Score 2: Formation a V·· angle;
- Score 3: Prominence of V·· angle (Fig. 3).

D. Ventral rampart: Different from males, the area of female ventral rampart is larger and wider when fully forming. With increasing age, the substance of the female ventral rampart becomes loose and full of the mesh rather than tuber-like as in males. Four stages were defined and scored.
- Score 0: No formation of ventral rampart;
- Score 1: Local ventral rampart;
- Score 2: Fully developed ventral rampart;
- Score 3: Ventral rampart becomes meshed and loose (Fig. 4).

E. Dorsal margin: The arc of the female dorsal margin is usually at a small angle compared to that of males due to the differences on the symphysial surface. Some female adults may be prone to shrinking, or even dents in the middle of the dorsal margin that presents earlier than the old male outlook. Four stages were defined and scored.
- Score 0: No appearance of dorsal margin;
- Score 1: Edged margin without a plateau;
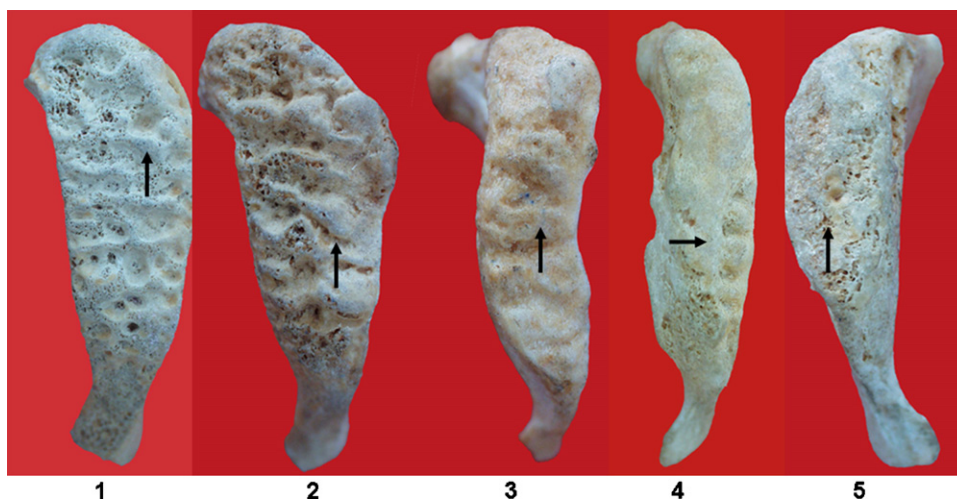
Fig. 1. Ridges and furrows on the symphysial surface: Scores 0–4. Score 0: ridges and furrows alternate distinctively; Score 1: transversal high ridges, furrows with few holes; Score 2: ridges low, blunt and furrows shallow; Score 3: flatness, ridges and furrows almost disappears; Score 4: pitted and eroded.