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Age Estimation by the Auricular Surface of the Ilium in Thais

Phruksachat Singsuwana[a], Phuwadon Duangto[b], Sithee Praneatpolgrang[c], Sukon Prasitwattanaseree[d], Suda Riengrojpitak[a,e,*], and Pasuk Mahakkanukrauh[f,*]
Forensic Science Graduate Programme, Faculty of Science, Mahidol University, Bangkok, Thailand

Abstract

Age estimation is an important step in human identification. The auricular surface of the ilium, a part of the pelvis, can be used to estimate age at death. The purpose of this study was to estimate age by using the auricular surface of the ilium in Thais. Samples of 210 Thai pelvises with an age range between 22-96 years were kindly supplied by the Department of Anatomy, Faculty of Medicine, Chiang Mai University. Five features of each auricular surface were assigned scores. These features were transverse organization, surface texture, macroporosity, apical change, and retroauricular area activity. Each score of the five features was combined to determine the composite score (CS) of both the left and the right auricular surfaces with no significant difference statistically (p=0.048) by using Wilcoxon test. The relationship between mean ages and CS was evaluated by using quadratic regression. Age could be estimated by the following equations: Age = - $0.465CS_L^2$ + $14.65CS_L$ - 29.67; and Age = - $0.59CS_R^2$ + $16.86CS_R$ - 36.8, where CS_L and CS_R were composite score of the left and the right sides, respectively. These equations were tested on the holdout samples (n=60). The percentage accuracy and standard errors of prediction age were 56.4% and 11 years by CS_L and 67.8% and 10.6 years by CS_R, respectively. Since age estimation has not been studied in Thais before, the equation obtained from this study might be useful in the field of forensic science in Thailand.

Keywords: age estimation, auricular surface, ilium, composite score, Thais

Introduction

Age estimation is one of the four steps in human identification which includes sex, age, stature, and race. From previous reports, researchers studied pubic symphysis (1), sternal rib end (2), and dental attrition (3). However, sternal rib end and pubic bone are so fragile and are lost. And though, teeth are well-preserved at archaeological sites, but seldom complete because they require a full set of teeth for age estimation (4).

The auricular surface of the ilium is a part of the pelvis. It can be used to estimate age at death because the auricular surface is only a small area which is not fragile and the pelvis is normally preserved in archaeological sites (5,6). population is different from others anyway. Therefore, this study was carried out on the auricular surface of the ilium in Thais for age estimation.

Methodology

Samples of 210 Thai pelvises with an age range between 22-96 years old from the Department of Anatomy, Faculty of Medicine, Chiang Mai University were observed. The fractured pelvis or pathology of the auricular surface or sacroiliac joint was excluded. Each auricular surface was scored for five features: 1) transverse organization. 2) surface texture. 3) macroporosity. 4) apical change and 5) retroauricular area activity.

[a]M.Sc., Forensic Science Graduate Programme, Faculty of Science, Mahidol University, Bangkok, Thailand.: doimadwings@hotmail.com
[b]Lect., Department of Anatomy, Faculty of Medical Science, University of Phayao, Phayao, Thailand.
[c]M.Sc., Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.
[d]Asst. Prof., Department of Statistics, Faculty of Science, Chiang Mai University, Chiang Mai. Thailand.
[a,e,*]Assoc. Prof., Forensic Science Graduate Programme, and Department of Pathobiology, Faculty of Science, Mahidol University, Bangkok, Thailand.: scsrr@mahidol.ac.th.
[f,*]Prof., Department of Anatomy, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand.: pmahanka@mail.med.cmu.ac.th.
[*]Corresponding author

1) *Transverse organization* refers to the horizontally orientated billows and striae that run from the medial to the lateral margins of the auricular surface (6) (Fig. 1A and Fig. 1B). The scoring system for transverse organization was given in Table 1.

Fig. 1A: Transverse organization on the auricular surface of a 31-year-old female (black circled area).
Fig. 1B: Irregular surface and macroporosity on the auricular surface of a 75-year-old male (black circled area).

Table 1. Scoring system for transverse organization

Score	Description
1	25–49% of surface is transversely organized
2	<25% of surface is transversely organized
3	No transverse organization is present
4	Irregular surface is present

2) *Surface texture* refers to a smooth surface with no pore (Fig. 2A) or a surface with shallow depressions as fine porosity or a surface with pores that reach down to the spongy bone as coarse porosity (Fig. 2B). The scoring system for surface texture was given in Table 2.

Table 2. Scoring system for surface texture

Score	Description
1	>50% of a smooth surface with no pore
2	>50% of a surface with shallow depressions
3	>50% of a surface with pores that reach down to the spongy bone

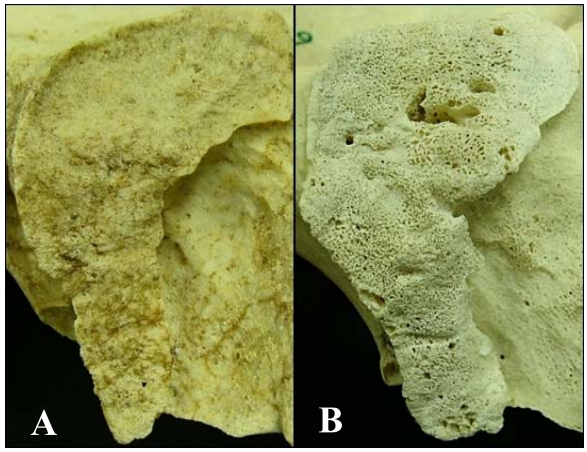

Fig. 2A: The auricular surface of a 47-year-old female was showing a smooth surface with no pore.
Fig. 2B: Coarse porosity on the auricular surface of a 72-year-old female.

3) *Macroporosity* (Fig. 1B) refers to a hole with smooth-edged ranging from 1 to 10 mm in diameter (5). It is scored with presence on one or both of the two demifaces of the auricular surface (6). Macroporosity covers a significant area of the auricular surface. The scoring system for macroporosity was given in Table 3.

Table 3. Scoring system for macroporosity

Score	Description
1	No macroporosity is present
2	Macroporosity is present on one demiface only
3	Macroporosity is present on both demifaces

4) *Apical change* can develop small osteophyte, lipping, or irregularity (Fig. 3). The scoring system for apical changes was given in Table 4.

Table 4. Scoring system for apical changes

Score	Description
1	Apex is sharp or a little lipping
2	Some lipping with smooth is present at apex
3	Irregularity is present at apex

Fig. 3. The auricular surface of a 75-year-old male was showing irregularity at the apex (black circled area)

5) Retroauricular area is an area posterior to the auricular surface. Activity in this area is an indicator of age. Young individuals present smooth in this area. Retroauricular activity increases porosity, fine to large osteophytes, and irregular surface in the older individuals (5) (Fig. 4A and Fig. 4B). The scoring system for retroauricular area activity was given in Table 5.

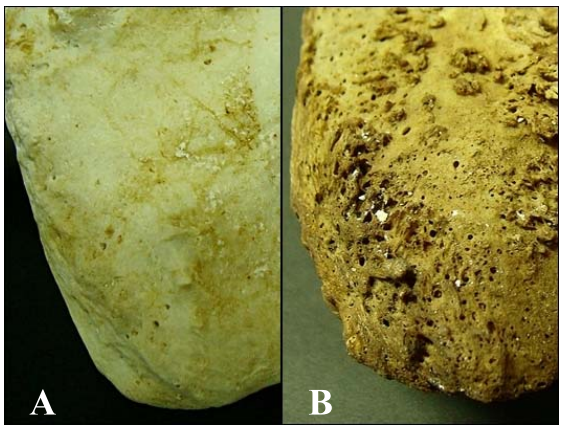

Fig. 4A: The retroauricular area of a 28-year-old female was showing no activity.
Fig. 4B: The retroauricular area of a 75-year-old male was showing irregularity.

Table 5. Scoring system for retroauricular area activity

Score	Description
1	None or slight retroauricular activity is present
2	Retroauricular activity is moderate
3	Irregularity of retroauricular area is present

The composite score (CS) was calculated from the sum of the scores of five features on auricular surface. Wilcoxon test was used to compare between left and right auricular surfaces by using significance level at 0.01. Then, the relationship of mean ages and CS were evaluated by using quadratic regression. The equations were tested on the holdout sample (n=60) for calculating standard errors of prediction age and the accuracy of percentages by age ranges: 20-29, 30-39, 40-49, 50-59, and over 60 years old in a cross tabulation.

Results and Discussion

The results of this study: the composite scores (CS) were the combined scores of the separate features which were transverse organization, surface texture macroporosity, apical change, and retroauricular area activity. A Wilcoxon test was calculated from the CS of all individuals with both left and right auricular surfaces that showed no significant difference statistically (p=0.048).

The CS of both left and right auricular surfaces was correlated with mean ages. The results of a quadratic regression could be used to estimate age by using the equations:
Age = $-0.465CS_L^2+14.65CS_L- 29.67$ and
Age = $-0.59CS_R^2+16.86CS_R- 36.8$, where CS_L and CS_R were composite scores of left and right sides, respectively (Fig. 6 and Fig. 7).

The quadratic equations were tested on the holdout samples (n=60), we found that the accuracy of percentages and standard errors of prediction age were

56.4% and 11 years old by CS_L and 67.8% and 10.6 years old by CS_R. The accuracy of percentages were calculated by age ranges of 20-29, 30-39, 40-49, 50-59, and over 60 years old. However, in this study the number of samples in the younger individuals was less than the older ones.

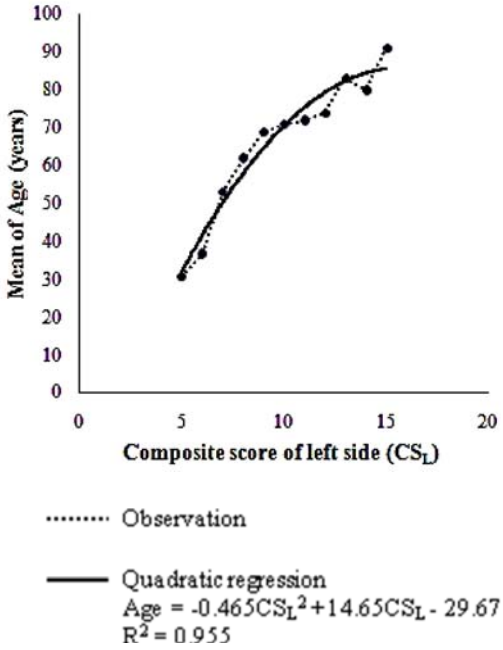

Fig. 6 The relationship between composite scores of left auricular surface (CS_L) and mean age by quadratic regression.

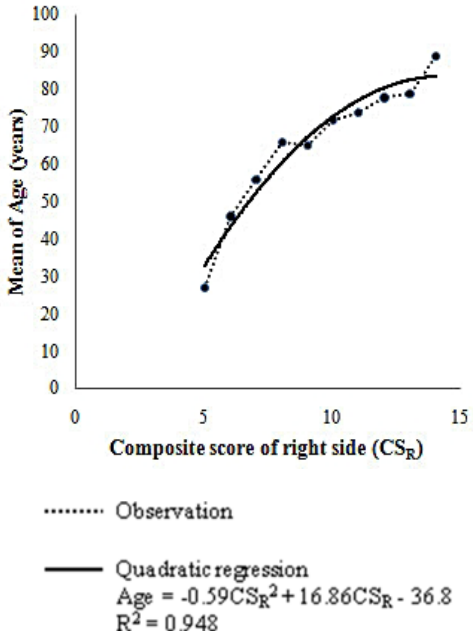

Fig. 7 The relationship between composite scores of right auricular surface (CS_R) and mean age by quadratic regression.

In previous studies, age estimation by observing the auricular surfaces with scoring system were tested mostly on Caucasoid individuals (6, 7). They used the features that consisted of transverse organization, surface texture (finely granular bone, coarsely granular bone, and dense bone), microporosity, macroporosity, and apical change. Since retroauricular area activity was found to be a poor estimator of age, and led to be excluded from their method. Their results were more accurate for the older individuals. However, this study could not observe some features of auricular surface as those previous studies due to different population groups.

In Thai samples, we did not observe the features of surface texture by classifying finely granular bone, coarsely granular bone, and dense bone because they were difficult to distinguish grains by eyes since microporosity was defined by pore less than 1 mm in diameter. It could be confused with porosity. The porosity on auricular surface was found in Thai samples. Then, we classified smooth surface (no pore), fine porosity and coarse porosity. The texture of the smooth auricular surface was found in the younger individuals, and becoming coarser in the older. In this study, we did not find transverse organization which more than 50% on the auricular surface. Thus, no transverse organization and becoming more irregular surface, including irregularity at apex, retroauricular activity and macroporosity present on one or both demifaces that were found in the older individuals.

Therefore, one population is different from others. The variations are from genes, health care, nutrition, physical activity types and environment. All these are contributing to aging process which can affect morphology, bone density or degeneration (8, 9).

Conclusion

Scores of five features of each auricular surface: transverse organization, surface texture, macroporosity, apical change and retroauricular area activity were combined to become composite scores for using in the equations: $Age = - 0.465CS_L^2 + 14.65CS_L - 29.67$ and $Age = - 0.59CS_R^2 + 16.86CS_R - 36.8$, where CS_L and CS_R were composite score of the left and the right sides, respectively. The standard errors of prediction age and the accuracy of percentages in age ranges of 20-29, 30-39, 40-49, 50-59, and over 60 years old when tested on the holdout samples were 11 years old and 56.4% by CS_L and 10.6 years old and 67.8% by CS_R.

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