

The roles of forensic anthropology in fetal death investigation

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ABSTRACT

Etty Indriati - *The Roles of Forensic Anthropology in Fetal Death Investigation*

Physical anthropologist who has a training in forensic anthropology may be requested to give an expert testimony. In case of discovery of fetal remains, forensic scientist should understand on what main principles of medicolegal examination the evidences are based. In relation with fetal skeletal remains several investigations should be emphasized, i.e. the origin of the skeleton, the maturity compared with gestational age, the prematurity, whether the fetus is viable at birth, is the case an abortion one, the furnish data indicating the possible cause of death, and the time elapsed between the interment and the discovery.

The aim of this paper is to discuss the role of forensic anthropology in fetal death investigation and to present case studies of fetal death. The methods used in this study are those by various experts, to determine the age of fetuses. The material of the case study is an unknown fetal remain from Java-Indonesia sent by the law enforcement agency. The study was carried out in the Laboratory of Bioanthropology and Paleoanthropology Faculty of Medicine in July 1990. The result shows the Ohtsuki's method proved to be the most appropriate in this case, probably due to the similarity in body size between the Japanese and Indonesian. The result also shows that fetal age identification is extremely sensitive to measurement error. An error of 2 mm. Can lead to 3 months difference in fetal age, therefore, a caliper with 0.005 mm. accuracy is suggested. The conclusion drawn from this study is that physical anthropology is a necessary part of forensic investigation.

Key Words: fetal remains investigation - Java origin - fetal age - identification method - forensic anthropology

ABSTRAK

Etty Indriati - *Peranan antropologi forensik dalam pemeriksaan kematian fetus*

Pakar antropologi ragawi yang telah mengalami latihan dalam antropologi forensik dapat diminta untuk bertindak sebagai saksi ahli mengenai suatu kasus forensik. Jika kasus yang dihadapi adalah sisa-sisa janin, pakar forensik harus menguasai prinsip-prinsip pemeriksaan medikolegal yang dijadikan dasar. Dalam kaitan dengan sisa-sisa kerangka beberapa pemeriksaan harus mendapat perhatian khusus, yaitu dari mana asal kerangka (manusia atau hewan), maturitas terhadap umur kehamilan, apakah prematur, apakah lahir hidup, apakah kasus pengguguran, data-data yang memberi petunjuk sebab kematian, dan waktu antara mayat dikubur sampai diperiksa.

Tujuan artikel ini adalah menguraikan peran antropologi forensik dalam pemeriksaan kematian fetus serta presentasi kasus kematian fetus. Metode yang digunakan dalam penelitian ini adalah metode penentuan umur fetus oleh berbagai pakar. Materi penelitian studi kasus ini adalah fetus tak dikenal dari Kedu, Jawa Tengah, Indonesia. Penelitian dilakukan di Laboratorium Bioantropologi dan Paleoantropologi Fakultas Kedokteran Universitas Gadjah Mada pada bulan Juli 1990. Hasil penelitian menunjukkan bahwa metode Ohtsuki adalah yang terbaik, kemungkinan karena ukuran orang Jawa lebih mirip dengan orang Jepang. Hasil juga menunjukkan bahwa identifikasi umur fetus sangat sensitif terhadap kesalahan pengukuran. Kesalahan pengukuran 2 milimeter dapat mengakibatkan kesalahan identifikasi umur sampai selisih 3 bulan. Untuk itu dianjurkan memakai kaliper dengan derajat ketepatan 0,005 milimeter. Kesimpulan dari penelitian ini adalah bahwa antropologi ragawi dan antropologi forensik merupakan bagian penting pada pemeriksaan kasus forensik.

INTRODUCTION

Physical anthropology has been a necessary part of forensic investigation. There are several cases of discoveries of decomposed fetuses and bones of fetuses which have ended up in the hands of physical anthropologists, having been sent for identification by law enforcement agencies. "Not all cases of forensic anthropology deal with adults or children; some deal with unborn fetal remains⁵." Fetal bones look completely different from adult bones. Due to immaturity, the cranial bones having no sutures and serration, are immediately coming apart during decomposition. For instance, the maxilla is apart from the cranium. The frontal, occipital, parietal, all separate from each other. The hip bones are present in three pieces. Metacarpal and metatarsal are formed lately. Therefore the number of fetal bones present can be one of the keys to estimate the fetal age.

The roles of forensic anthropologists in crimes involving fetuses.

Physical anthropologist who has a training in forensic anthropology may be requested to give an expert testimony. An expert witness usually does one or more of the followings⁶: a) draws upon fact and express professional opinion, b) reaches a conclusion, c) responds to hypothetical questions, d) explains professional procedures to the court or jury, and e) requires modification of a particular question when a simple yes or no answer would not suffice.

In the case of discovery of fetal remains, forensic scientists should understand on what the main principles of medicolegal examination are based. What do we, physical anthropologists, have to answer on the report in terms of the medicolegal context? If with adult skeletal remains the determination of the sex, stature, race, and age is important, so it is with fetal skeletons, with several emphasis⁴.

1. Are the bones of human or of animal origin? Are they fetal bones, or are they the skeletal parts of some birds or smaller mammals?
2. If the bones proved to be a fetal origin, what is their lunar age? Do the maturity, body length, and age of the fetus correspond to the gestational age of the suspected human?

3. Could the fetus have been viable at birth, or was it born prematurely, in a non-viable state?
4. Could the fetus have originated from the suspected woman whose pregnancy terminated in the incriminated way and time?
5. Did the investigation furnish data indicating the circumstances or the possible cause of death?
6. How much time may have elapsed between the interment of the fetus and its discovery?

In terms of fetal origin, if the cranial bones are present, the proportion of cranial size is large relative to the bones of the extremities. In addition, the secondary ossification centers have not fused yet in fetal humans, and the foramen magnum is anteriorly located, whereas in animals it is usually more posterior. Some animal remains that could be erroneously interpreted as fetal humans are: chicken, cat, dog, weasel, rabbit and frog bones^{6,7}.

The time that may have elapsed between the interment of the fetus and its discovery can be estimated by the degree of decomposition, which is dependent upon the environment. Wet soil has a more preserving effect than dry soil^{8,4}. Therefore, in the case of a suicidal or murder pregnant woman, the fetal remains will perhaps last longer since the fetus is still in the womb. The decomposition of ligaments and cartilages takes about 5 years or more, and buried bones are much lighter than fresh bones⁴.

If the fetus is burnt, it decreases in the three dimensions. There are several degrees of shrinkage in the various stages of desiccation (to dry out completely), carbonization, and calcination (to heat with high temperature without causing it to melt). Schrader⁴ concluded that the actual body length decreases about 5 cm in the burnt fetal case, and found that there was less decrease in size in the case of a more mature fetus. But in general, in the case of a burnt fetus, adding 1-1.5 lunar months is suggested from the normal measurement, because of the shortening and shrinkage of the bones. The burnt fetus will undergo chipping, fissure and fragmentation in the last lunar month, but in the early lunar months, deformation is common. Besides the fetal maturity, the temperature is important. Klement and Trommel 1932 (in⁴) stated that white heat in 20-25 minutes

was sufficient for complete destruction to burn up the bones.

Stage of development is also important to strengthen fetal age estimation. Three criteria for the developmental stage of the tympanic plate is suggested⁹: 1) the petro-mastoid portion of the temporal bone is present, but the tympanic ring has not yet developed, 2) the tympanic ring is incomplete (U-shaped) and partially adheres to the petro-mastoid portion, and 3) the tympanic ring adheres well to the temporal bone inferiorly, and the previously open ends of the 'U' are closing toward each other, although closure is incomplete. Two researchers^{9,10} used criteria offered by⁹ to examine 95 blacks and 71 whites from the fifth fetal month to the third postpartum month. The result showed no significant difference between the two races, and they concluded that during the fifth to eighth fetal month, stage one has already been reached. If stage three is complete it is mostly postnatal.

With a knowledge of various methods of fetal bone development, fetal age and sex estimation, physical anthropologists should be able to be consulted by law enforcement agency if fetal remains are discovered.

Case studies.

1. Case One⁵:

"A woman reported to her gynecologist that she had found 'gritty material' during her recent menstrual periods. She brought samples of this to the gynecologist, who recognized what he thought was fetal bone. The patient had been pregnant 5 years previously. The doctor who treated her at that time did a curettage, but he encountered so much bleeding that he stopped before evacuating the entire uterine contents."

On case one, the researcher⁵ identified the fetal age as 13 to 14 weeks, and concluded that the fetus might be the result of partial curettage 5 years ago that left behind bits of fetus, or alternatively, an unrecognized pregnancy that led to spontaneous miscarriage. But because he found only the cranial, sternal and clavicular bone fragments, Kerley assumed that the rest of the bones may had been curetted away, therefore the earlier conclusion is probably right. In addition, the radiograph showed that the woman had a bicornu-

ate uterus, perhaps allowing the fetal bones to lie there.

2. Case Two⁴.

The following bones were discovered:

1. One broken and defective braincase. The maxillae and the cheek bones were totally lacking. Moreover, the bones were injured to various degrees due to putrefication of the soft parts and decay of the bones.
2. One bone very similar to the humerus of a newborn infant.
3. One bone very similar to the ulna of a newborn infant.
4. Two very fine bones resembling nasal bones
5. Two femoral bones.

The researchers⁴ concluded that it was not fetal bone because: 1) the skull was too small for the skull of a mature fetus, 2) all sutures of the cranial bones were united by bony fusion, 3) the foramen magnum was found in the back part of the basicranium, while in the human fetus it is localized in the middle part.

3. Case Three (this study):

On July 11, 1990 the Laboratory of Bioanthropology & Paleoanthropology, Gajah Mada University Faculty of Medicine, Yogyakarta, received a bottle contained 200 cc of 10% formaldehyde with decomposed fetal remains in it, from the Police Department of Kedu, Central Java. There was no other information about the surrounding environment of the fetal discovery. The Police Department only searched for the answer of the fetal age.

RESULTS

From the observation of case three, I determine that there are a total of 72 pieces of bones from one human individual. There are 17 vertebrae, 10 left ribs, 10 right ribs, a left temporal, right and left sphenoids, right and left zygomatics, an occipital, a left frontal, right and left parietals, right and left maxillae, a right mandible, right and left clavicles, right and left scapulae, right and left humeri, right and left ulnae, right and left radii, a left femur, 5 metatarsals, and 6

phalanges. The measurement of the bones in case three is shown on TABLE 1.

TABLE 1. - The measurements of fetus in case three

Bones	Left (mm)	Right (mm)
Femur length	47.92	-
Humerus length	43.97	44.03
Ulna length	41.76	41.73
Radius length	34.98	34.26
Clavicle length	30.62	30.62
Scapula, length	30.60	30.67
breadth	19.00	19.20
height	24.49	24.52
Mandible		
corpus height	-	4.40
ramus breadth	-	11.50
Maxilla horiz. length	15.70	15.40
diagonal	20.20	20.00
Frontal\		
medial	46.36	47.10
lateral	46.25	45.75
superior	27.74	27.53
inferior	27.50	27.00
Temporal		
anterior	16.25	-
posterior	13.50	-
superior	17.74	-
inferior	17.51	-
Occipital		
transversal length	47.00	
sagittal length	37.00	
Parietal		
horizontal length	54.35	55.61
vertical length	49.50	50.20
Rib		
I	15.85	16.50
II	29.40	32.35
III	42.47	43.25
IV	41.10	45.70
V	45.91	46.10
VI	48.37	48.57
VII	45.27	44.10
VIII	43.55	45.70
IX	36.40	45.10
X	37.27	41.55

The determination of the fetal age used 4 methods^{1,2,3,4}.

1. Determination of the fetal age using crown-rump length estimation², and table of fetal age¹¹:

Formula: CR length = 5.35 X humerus + 15 mm = 5.00 X femur + 15 mm

- a) Left humerus 5.35 X 43.97 = 235.24 + 15 mm (6-6.5 months)
- b) Right humerus 5.35 X 44.03 = 235.56 + 15 mm (6-6.5 months)
- c) Left femur 5.00 X 47.92 = 239.60 + 15 mm (6-6.5 months)

The fetal age: 6-6.5 months.

2. Determination of the fetal age using arch length measurement and "table of fetal age in months"³.

Using Ohtsuki method³, TABLE 2 indicates that the fetal age of case three ranges between 6-8 months with high frequency of the occurrence at the age of 7 months.

TABLE 2. - Fetal age identification in case three using the Ohtsuki method (1977)

Age Case 3 (mm)	4-5 m	6 m	7 m	8 m	
Frontal					
vert.	46.36	22.50	34.38	<u>43.90</u>	<u>50.70*</u>
transv.	37.50	23.25	29.31	<u>36.80</u>	41.80
Parietal					
vert.	57.41	38.50	45.62	<u>57.30</u>	70.00
transv.	55.61	35.75	45.00	<u>56.20</u>	67.40
Occipital					
vert.	41.77	24.00	29.77	<u>41.50</u>	50.60
transv.	35.82	30.00	<u>36.15</u>	46.50	57.60
Temporal					
vert.	16.25	9.25	11.31	<u>16.70</u>	19.00

*Underlined and bold numbers indicate the result of measurements that close in the range of the age in months of Ohtsuki's method. Vert = vertical; transv = transversal; and m = months.

3. The determination of the fetal age using "Rapid determination of fetal age"⁴.

As it shown in Table 3 using Fazekas and Kosa (1978) method⁴, the result of measurement spread in the range of 6 to 8 months but the high frequency of occurrence is at the age of 7 months. This is matched with the method of Ohtsuki³, and only 0.5-1 months older from the Mehta & Singh² method combined with Moore's¹¹ table. Note that Fazekas and Kosa⁴ used a European sample, Ohtsuki³ used a Japanese fetus sample and Mehta and Singh² used an Indian sample. This fetal discovery case is Indonesian, which is in general assumed to be smaller than European, and in the range between Japanese and Indian, in size.

Note that at certain times, the measurement decreases (-) even though the fetus is getting older (TABLE 3). The reversal of the ratio takes place in cranial bones. This is because the fetal growth needs to reach a normal proportion. At two and a half months old, the fetal upper head is still as wide as the shoulders and has a long face¹². Then it gradually reaches a normal proportion having a shorter face and the shoulders wider than the head.

TABLE 3. – Fetal age determination using the Fazekas and Kosa method

Age		6 m.	6.5 m.	7 m.	7.5 m	8 m.
Case 3 (millimeter)						
Occipital						
horiz.	L 35.82	29.00	35.50*	47.00	48.00	43.50
vert.	41.77	28.00	34.50	35.00	48.00	45.30
Parietal						
horiz.	L 54.35	43.00	47.70	51.00	63.00	52.80
	R 55.61					
vert.	L 49.70	39.00	46.50	35.00	50.00	54.60
	R 50.20					
Maxilla						
a.	L 15.70	12.50	14.70	17.00	19.00	20.00
	R 15.40					
b.	L 20.20	19.00	23.50	25.00	26.00	24.00
	R 20.00					
Mandible						
length,	L 34.00	30.00	32.20	34.00	37.00	40.50
Rib						
	L	R				
I	15.8	16.5	12.00	15.20	18.00	18.00
II	29.4	32.3	21.00	28.10	29.00	32.00
III	42.5	43.3	29.00	35.50	37.00	43.00
IV	41.1	45.7	33.00	41.60	41.00	47.00
V	45.9	46.1	38.00	45.70	44.00	51.00
VI	48.4	48.6	38.00	45.30	43.00	53.00
VII	45.3	44.0	35.00	46.50	44.00	53.00
VIII	43.5	45.7	35.00	43.00	40.00	50.00
IX	36.4	45.1	33.00	34.30	37.00	44.00
X	38.3	40.0	28.00	32.00	31.00	35.00
Clavicle						
	L	R				
	30.6	30.6	26.00	30.10	31.00	33.00
Scapula,						
	L					
length	19.00		19.00	21.10	21.00	24.00
height	24.49		20.00	23.30	22.52	27.00
breadth	24.49		18.00	19.50	20.00	22.00
Femur						
	L	R				
vert -	47.1		38.40	45.40	47.00	56.00
horiz -	11.7		9.00	11.40	-	14.00
Humerus						
vert	43.5	42.9	36.00	42.00	42.00	47.00
hor.	10.2	10.2	6.00	9.40	11.00	11.00
Radius	35	34.3	30.50	34.80	34.00	38.00
Ulna	41.7	41.7	33.50	38.50	38.00	45.50
Frontal						
vert	46.4		31.50	39.10	37.00	44.00
hor.	37.5		27.50	32.60	35.00	37.50
Temporal						
vert	16.25		12.00	14.70	16.00	18.00
hor.	25.00		21.00	22.60	25.00	25.00

*Underlined and bold numbers indicate the result of measurements that close in the range of the age in months of the Fazekas and Kosa's method. Vert-vertical; hor-horizontal; L-left; R-right; and m-months.

4. Determination of the fetal age^{1,13}.

Fetal stature = 7.92 Humerus -0.32 + 1.8 cm
 = 13.8 Radius -2.85 + 1.62 cm
 = 8.73 Ulna -1.07 + 1.59 cm

a) Left humerus (7.92 X 43.97)-0.32 + 1.8
 = 349.72 mm = 34.97 cm (6.5-6.75 months)

b) Right humerus (7.92 X 44.03)-0.32 + 1.8

= 350.22 mm = 35.02 cm (6.75 months)

c) Left radius (13.8 X 34.98) -2.85 + 1.62
 = 481.49 mm = 48.15 cm (9.25 months)

d) Right radius (13.8 X 34.26)-2.85 + 1.62
 = 468.32 mm = 46.83 cm (9 months)

e) Left ulna (8.37 X 41.76) -1.07 + 1.59
 = 350.05 mm = 35.00 cm (6.75 months)

f) Right ulna (8.37 X 41.73) -1.07 + 1.59
 = 349.80 mm = 34.98 cm (6.5-6.75 months)

Results of the examination for case three:

1. The bone is human, apparent from the proportion of the cranial bones to the bones of the extremities, and the unfused secondary ossification centers.
2. The lunar age is 7 months (6.5-7 months)
3. The fetus could be viable at birth since at this stage the fetus should be capable of breathing air (relatively mature respiratory system). The fetus could survive with medical care, if born prematurely.
4. The possible cause of death was induced abortion, since it is uncommon to have a spontaneous abortion during late pregnancy.

The possible induced abortion very likely was by mechanical irritation, not by chemical agent, due to the relatively intact/undissolved fetal bones. If it was aborted by chemical agent, like hypertonic saline injection (due to the decomposed flesh), it was very possible to lead to the death of the mother. Eventhough the fetus in this case was preserved by 10% formaldehyde, one study¹⁴ shows that formaldehyde preservation for a period over six months leads to no great change in the external dimensions of the fetal body. The chemical agent synthetic hormone (progesterone or antiprogesterin) is impossible to use in the abortion of late pregnancy, since its effect is merely to contract the uterus muscle and to deactivate the hormonal body, which is too late for a 7 month fetal age that already has movement reflex to sustain her/his life.

5. The time elapsed between the interment of the fetus and its discovery might have been very short, since ligamentous attachment is present, fetal flesh is partially attached to the bone, the hair that was attached to the head flesh had also appeared, and there was no erosion on the surface of the bone. The elapsed time between

the time of death and the discovery might have been less than one month.

6. To answer whether the fetus might have originated from the suspected woman, it should be matched with the manner of disposal, and the suspected woman's condition and history. Therefore it is very important for the forensic anthropologist to be informed of the circumstances of the environment of the fetal discovery to support the final conclusion.
7. After the report was done, I was told that the fetus was removed from the abdomen of a decomposed pregnant woman in the autopsy room. The suspected boyfriend confessed that "they" went together to an unskilled abortionist.

DISCUSSION

The fetal age ranges of case three was from 6 to 6.5 lunar months except for the formula using radius length, which gave 9-9.25 lunar months age. Does it mean that in this case the radius length is longer in proportion to the body height/stature? The fact that the table 3 of Fazekas & Kasa⁴ shows the radius length of 34.26 - 34.98 mm in the range of the age of 6.5 to 7 months suggests that the radius formula by Olivier & Pineau¹ should be reconsidered, since all other measurements available result in range of 6 to 7 months. In addition, the distal femoral epiphysis has not yet appeared, which suggests that the age is less than 9 months⁸.

Of the various methods of fetal age determination using measurements of the bones, the best method is the rapid determination of fetal age⁴ combined with method using arch length measurement of the cranial bones³. In addition, the presence of the bones and ossification centers should be observed to strengthen the conclusion. It should be noted that the fetal measurements are very sensitive in age determination. The differences of 2 mm can lead to 3 months age differences. Caliper with 0.005 mm. accuracy is suggested.

Dealing with the medicolegal context, the forensic scientist should also be able to differentiate a neonate from newborn infant; in case of homicide, a newborn which usually dies from strangulation or the mother lets the newborn baby die by

throwing her/him away in an isolated area. There are six epiphyseal centers which appear at birth: the head of the humerus, condyle of the femur, condyle of the tibia, talus, calcaneus, and cuboid⁸. The crown-rump length is often over 35 cm^{11,13}. In the physical development at term, the petrous part of the temporal bone is ossified with the squamous part and mastoid process, and the tympanic part is fused with its basal part⁴.

CONCLUSION

As a field of science that studies human bones, physical and forensic anthropology has long been contributing to medicolegal issues in regard to the discovery of skeletal human remains. Forensic fetal osteology is an important part of that study but is very distinct in many ways. It is a branch of physical anthropology which has much to offer, and should be given special attention for future research.

ACKNOWLEDGEMENTS

I am grateful to Professor Jane Buikstra for the privilege to be her graduate student at the University of Chicago. I am in debt to Professors Teuku Jacob of Gadjah Mada University, Russel Tuttle and Alan Kolata of the University of Chicago, and Jane Buikstra of the University of New Mexico for their inspirations to be productive either in literature or experimental research as academics. Professors Teuku Jacob, Soedjono Aswin, Soenarto Sastrowijoto and Abdul Salam Sofro of the Gadjah Mada University had consistently given their moral support during my study in the United States and I am deeply thankful for that.

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