

BRIEF COMMUNICATION

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Determination of Gestational Age from Lunar Age Assessments in Human Fetal Remains

REFERENCE: Huxley AK, Angevine JB Jr. Determination of gestational age from lunar age assessments in human fetal remains. *J Forensic Sci* 1998;43(6):1254–1256.

ABSTRACT: Occasionally forensic fetal remains are submitted to the office of the medical examiner for age determination. A variety of literature and many techniques are available for this assessment depending upon the overall condition of the remains. If one uses traditional forensic anthropological sources, then age is calculated in lunar months; if one uses other sources—embryological, anthropological and sonographic—then age is reported as gestational weeks. For comparison between ages derived from these various studies, especially in cases involving age assessments of incomplete fetal remains that may be partially damaged by taphonomic factors, it is necessary to convert between lunar age and gestational age. The objective of this study is to present a conversion table for exact correspondence between lunar months and gestational weeks from the point of conception to term. This information is useful for developing a forensic profile at any gestational age as well as providing a means to assess the probability of viability at the time of death.

KEYWORDS: forensic fetal osteology, fetal remains, gestational age determination, lunar age determination, diaphyseal length, fetal viability

In the course of their analyses, forensic specialists are sometimes required to determine gestational age from forensic fetal remains. Accurate age determination is necessary when addressing potential fetal viability *postpartum* in a variety of medicolegal contexts, including miscarriage, second and third trimester abortions, manslaughter and murder. Considerable literature exists for these purposes depending on the nature of the forensic case in question, with due consideration given to the general condition of the remains, the circumstances of the collection process and the possibilities for altering the evidence during the analysis. Special consideration must be given to the aging technique used in the study—gestational or lunar age—since it is generally not defined but rather implied in the text, charts and graphs of these publications.

The data presented in the present paper provide a means to link the two general methods: lunar age determination in months from the traditional forensic anthropological sources (1–7) to gestational age determination in weeks from a variety of embryological (8,9),

physical anthropological sources (10) and modern obstetric and gynecological studies (11–24). This information will be useful to quickly determine gestational age from lunar age values and to assess the possibility of fetal viability at the time of death for the case fetus.

Materials and Methods

In one of their articles, Olivier and Pineau (1) listed a means to compare lunar age to “civil” or gestational age in human fetuses. A conversion chart is presented in Table III of their publication that compares lunar months by weeks of the month and “civil” months by percent of the month, beginning at fourth month first week and ending at the tenth lunar month. In the present study, the data found in Table III are modified for the purposes of expanding the conversion table to include conception to ten lunar months. Such an analysis is necessary since the two ages are not compatible with each other during any given fetal period, and therefore require conversion.

Age determination in months is a more traditional method based on the 28-day lunar cycle, in which the pregnancy lasts 280 days over ten lunar months (LM). By contrast, gestational age determination in weeks is based on a 31.1-day solar calendar, in which the pregnancy lasts a total of 280 days over approximately 40 weeks during nine gestational months. In each technique, age is calculated from onset of the last menstrual period (LMP) at 280 days or from the point of conception at 266 days. These formulae are as follows: lunar months = gestational months \times 31.1 calendar days/28 lunar days and gestational months = lunar months \times 28 lunar days/31.1 calendar days. For these dates to be used for accurate assessment of fetal age *in utero* for obstetric purposes, the physician requires knowledge of the patient’s average length and regularity of her menstrual cycle as well as an accurate date for LMP from self-recalled reproductive history. If this history follows a regular 28-day menstrual cycle, the values listed above are applicable; if not, these values need to be modified. In order to apply these dates to forensic fetal remains, it is necessary to establish whether the fetus followed normal parameters for growth and development. One possible technique is to assess body proportions in relation to diaphyseal growth and gestational age (e.g., biparietal diameter to femur length for specific age). This process may be exceedingly difficult if the remains are incomplete, altered through taphonomic factors or in a skeletonized state.

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Received 20 Feb. 1998; and in revised form 2 April 1998; accepted 22 April 1998.

Results

In Olivier and Pineau's paper, Table III links lunar months to "civil" or gestational months, beginning at 4¼ lunar months and ending at term. Although issues of fetal viability do not arise until later in the pregnancy, the conversion of fetal age prior to this age is necessary, since forensic fetal remains may be submitted that are younger than 4¼ lunar months and age determination from fetal remains of any age may be relevant to judicial proceedings.

An analysis of the results listed in Table 1 herewith suggests that lunar age and gestational age do not directly correspond early in pregnancy and the discrepancy becomes more obvious later in pregnancy. At 84 days of pregnancy, little difference exists between lunar age and gestational age (3.00 LM vs. 2.70 GM), whereas at 175 days a wide discrepancy exists (6.25 LM vs. 5.63 GM). At term, there is a difference of a month (10.00 LM vs. 9.00 GM). If a forensic fetal case were submitted and calculated to be 7.25 to 7.50 LM, conversion to gestational age is necessary to assess the possibilities of fetal viability. In such a situation the fetus would be 6.52 to 6.75 GM or 26 to 27 gestational weeks, and thus possibly viable through preterm delivery and appropriate postnatal care. This scenario demonstrates the need to convert lunar months to gestational months to assess age and possibilities for viability.

Discussion

The material presented in this paper is an expansion of Olivier and Pineau's work. We present a continuation of their conversion table between "civil" and lunar age directly from the time of conception to birth. These data provide a means to link the two main methods for age determination: (1) lunar age from forensic anthropological sources, and (2) gestational age from embryological, bioanthropological and sonographic criteria for the determination of age at death. Due consideration must be given to the overall

state of the remains (complete, incomplete, macerated, decomposed or skeletonized), the nature of the collection process (effects of formalin on morphology, trauma from tools used, compression of body parts during transport) and, finally, the likelihood of altering evidence during analysis, including removal of skeletal elements for gross examination. All are necessary for choosing the best set of studies to develop accurate age assessments.

Summary

Transformation from lunar age to gestational age is important to accurately assess the developmental stage and potential viability in human fetuses. For instance, if one were to compare modern sonography studies on living fetuses *in utero* with the data from the skeletal series presented by Fazekas and Kósa (3), such as in the case analysis by Huxley (25) and the subsequent case report by Huxley and Sibley (26), or to calculate gestational age on modern forensic fetal remains with Olivier and Pineau's (1,2) regression formulae or Fazekas and Kósa's (3) tabular data, the transformation from lunar age to gestational age is clearly necessary. This application is especially relevant to forensic specialists, who may be called on to assist in developing the forensic profile of remains for medicolegal purposes.

Acknowledgments

Sincere thanks are given to W. H. Birkby, Ph.D., D-ABFA, Forensic Science Center, Pima County, AZ for editorial assistance during preparation of this manuscript and to Sue Jimenez, M.A. for translation of the Olivier and Pineau works from French. Presentation of this work at the 1998 AAFS meetings in San Francisco, CA was financially supported by a Graduate and Professional Student Travel Grant awarded by the Graduate College at The University of Arizona, Tucson, AZ.

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TABLE 1—Comparability of lunar age and gestational age by day of pregnancy.*

Days of Pregnancy	Lunar Months	Gestational Months	Days of Pregnancy	Lunar Months	Gestational Months
0	0.00	0.00	140	5.00	4.50
7	0.25	0.23	147	5.25	4.73
14	0.50	0.45	154	5.50	4.95
21	0.75	0.68	161	5.75	5.18
28	1.00	0.90	168	6.00	5.40
35	1.25	1.13	175	6.25	5.63
42	1.50	1.35	182	6.50	5.85
49	1.75	1.58	189	6.75	6.08
56	2.00	1.80	196	7.00	6.30
63	2.25	2.03	203	7.25	6.52
70	2.50	2.25	210	7.50	6.75
77	2.75	2.48	217	7.75	6.97
84	3.00	2.70	224	8.00	7.20
91	3.25	2.93	231	8.25	7.33
98	3.50	3.15	238	8.50	7.65
105	3.75	3.38	245	8.75	7.88
112	4.00	3.60	252	9.00	8.10
119	4.25	3.83	259	9.25	8.33
126	4.50	4.05	266	9.50	8.55
133	4.75	4.28	273	9.75	8.77
			280	10.00	9.00

* This conversion chart is modified from Olivier and Pineau's Table III (1).

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