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The use of dental criteria for estimating postnatal survival in skeletal remains of infants

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Abstract

Separate cemeteries and/or burial loci for infants have been variously interpreted as reflecting segregation by age, infanticide or even child sacrifice. Attempts to distinguish between these factors rely primarily on the age distribution found. Currently long bone length is the most commonly used method for fetuses and infants in the perinatal period, but its accuracy is affected by the inherent variation in size for age. We show here how to distinguish between death in the perinatal period and that occurring later in infancy through identification of the neonatal line in ground sections of deciduous teeth. The methodology is reviewed and applied to validate estimations of postnatal survival for infant remains recovered from two archaeological sites in Israel.

Keywords: Ashqelon; Dor; Age estimation in infants; Postnatal survival; Infanticide; Dental development; Neonatal line

1. Introduction

At the present time long bone length is the most commonly used method for aging fetal or young infant remains recovered from archaeological sites. However, in addition to genetic factors, maternal age, health and number of previous pregnancies affect birth weight and size of even full term infants [21]. A nation-wide study carried out in the United States by Hoffman et al. [18] found that 43% of live births occurred between the seventh and ninth gestational months. Consequently, birth weight and thus size may vary by more than 50% even between full term siblings. The accuracy of gestational age estimates based on size of long bones to assess postnatal survival is then problematic for establishing the duration of postnatal survival and does not provide population specific standards of size correlated to age at birth [21]. This means among other things that infant remains may mistakenly be described as fetal if they represent low birth weight infants who were born alive, but died in the perinatal period.

Discrimination between stillborn infants and those dying later is important both for forensic cases and for paleoepidemiological studies. It also provides the means of interpreting attitudes of past societies to infant death as expressed in funerary practices. This is especially pertinent when infant remains are found in unusual locations, such as the drain at Ashkelon [39], indicating that little care was given to their burial [10]. Isolated infant burials may represent the decision of an individual or family unit to dispose of unwanted infants without the ceremony attendant on burial in a designated cemetery, but it may also represent the decision of a society to deny some infants full burial rites for religious or social reasons [13]. However, large accumulation of infant remains in a defined locality reflects prevailing attitudes towards infants. These may include sanctioning of infanticide or child sacrifice, or alternately the exclusion of infants under a certain age from designated cemeteries [10,32,42,43].

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Ethnographic reports and archaeological findings have shown that in many communities, mourning rites and infant burial patterns differ from those accorded to older children or adults [2,39,40]. The cut-off age may vary from one month to as much as 6 years. This is a much larger age range than that expected in the event of infanticide which usually occurs within one or two days of birth [22]. In this context it is necessary to differentiate between infanticide and death from natural causes during the first month of life. Infant sacrifice may be restricted to a specific age group and sex, as has been suggested from various interpretations of the Bible suggesting sacrifice of the first born male child [9,23]. It may, however, encompass a much wider age range and both sexes if sacrifice is made during festivals or in times of danger as practiced as recently as the 19th century by some tribes in India [31]. Examples of ancient texts indicate that infant sacrifice was practiced at Carthage [4,15,23,24,42,43] and infanticide in ancient Greek and Roman societies [10,22,32].

A number of recent studies have attempted to examine these hypotheses by comparing the age and sex distribution of infants found in unusual contexts with that expected in the event of death from natural causes [1,14,12,10,39,26,27,34,35]. The two main limitations of this approach are firstly the accuracy of age estimations and secondly the extent to which diagenesis affects preservation and identification of the small, incompletely mineralized infant skeletons [17]. In this paper we focus on the first problem and propose that the use of the neonatal line can discriminate between death in the first week of life (perinatal) and that in the succeeding three week period. Together these account for most deaths in the first year of life.

The terms "fetal", "neonatal", "perinatal" and "infant" are used here as defined in the medical literature [21]. Fetal refers to unborn infants, perinatal death refers to infants born alive but dying between birth and seven days, neonatal includes birth to one month, and infant is restricted to 0–12 months.

1.1. The neonatal line

Tooth development is more buffered against environmental insults than skeletal development [5,16,25], and provides a more accurate standard for estimating gestational age [7,8,20]. At birth the deciduous tooth germs are incomplete and the enamel present is only partially mineralized [7,8,19]. Following birth the enamel crown increases in thickness by apposition of additional layers of enamel and increases in length as new ameloblasts are recruited at the base of the tooth germ. Enamel apposition is 4–5 μm per day [37,38]. The neonatal line identified on thin sections is the first layer of enamel laid down after birth. It is hypomineralized and characterized by a marked change in the direction of the enamel rods. The difference in opacity between the enamel of the neonatal line and that formed earlier or later renders it easily visible on ground sections at even low magnifications, while the marked change in direction of the enamel rods can be easily visualized on SEM [45]. The phenomenon has been attributed to the characteristic drop in serum calcium values that occurs in the two to three day period following birth [36]. The neonatal line has long been used for research into developmental disorders as well as for forensic purposes [16,45,38] but has only rarely been applied in archaeological investigations. The work of Bondioli and Macchiarelli [3] on the osteodental pathology of skeletal remains from Portus, Rome, is a notable exception.

Since all the deciduous teeth begin calcifying by the fifth lunar month (20th week in utero), the neonatal line can be identified on any of the deciduous tooth germs and usually on the first permanent molar provided that the infant survives for at least 7–10 days – the time necessary for visualization of the neonatal line as a band between pre- and postnatal enamel [45]. Since the neonatal line forms a clear delimitation between the extent of prenatal and postnatal crown formation it is independent of gestational age or size at birth.

The amount of enamel formed after birth can then be measured to evaluate the duration of postnatal survival in skeletal remains. Measurement of crown height at parturition as defined by the neonatal line in teeth of infants that survived and its comparison to crown height in teeth of infants assumed to have died soon after parturition also provides a means of evaluating the effect of size differences at parturition and their contribution to survival. Epidemiological estimates of infant mortality show that over 70% of all neonatal deaths occur in the first seven days after birth and that low birth weight is one of the major causes [45]. Identification of the location of the neonatal line in relation to crown development of infants surviving for more than seven days then provides the necessary degree of accuracy for establishing crown height at birth irrespective of gestational age. We have applied this method to assess postnatal survival of infants recovered from two archaeological sites in Israel.

At the first site, Ashqelon, the contents of a disused drainage channel leading from a Late Roman–Early Byzantine bathhouse were found to include the remains of over 100 infants. The drain appeared to have been used as a rubbish dump since the infant remains were mixed in with broken pot sherds and isolated faunal remains [39]. The second site is an Ottoman cemetery [41] on the Carmel coast. It dates to the 17th–19th centuries A.D. and served as the local cemetery for a small hamlet. Here nearly 200 individuals of all ages had been interred in cist graves.

2. Materials and methods

Upper first deciduous molar tooth germs were present in 14 infants from Ashqelon and 13 infants from Dor. Crown height (CH) was measured on the buccal surface from the incisal tip or tip of the highest cusp to the developing edge parallel to the long axis of the crown. This was carried out using a digital sliding caliper and recorded to 0.1 mm. From this sample a subsample of six tooth germs representing all stages of crown development were selected for sectioning. They were placed in ethanol, then air dried overnight and heated in a drying oven to 37 °C. They were then placed in a vacuum together with the embedding material, a low viscosity epoxy (epo thin), for 5 min to remove air bubbles and then embedded and returned to the vacuum for a further 5 min. The specimens were left at room temperature overnight for the epoxy to harden and sliced using an isomet with a diamond blade. The first cut was made with the blade perpendicular to the long axis of the tooth through the tips of the mesio-buccal and lingual cusps and the cut surface sealed with thin smear of superglue to prevent crumbling. The second cut was made parallel to this and the resulting thin section stuck to a clean slide using mounting wax (crystalbond 509). The slides were then lapped to a thickness of approximately 150 μm using a minimat. These sections were photographed to magnifications of ×2 and ×10 under an optical microscope and measurements were taken as shown in Fig. 1.

The first measurement gave the height of the crown on the section and was compared to the height previously recorded on the intact tooth. It was defined as the vertical distance between the highest point of the mesio-buccal cusp of molars and the intercept of the same line with the cervical border of the section (CH). The second measurement was the estimated height of the tooth at birth. It was defined as the vertical distance between the highest point of the neonatal line on the mesio-buccal cusp of molars and the intercept of the same line with the dentino-enamel junction (DEJ) on the same section. The third measurement was the distance between the neonatal line and the cervix of the tooth. This represented apical growth of the crown (Fig. 1). The reliability of crown height as a predictor of survival was assessed with reference to crown height at birth extrapolated from specimens in whom the presence of postnatal enamel demonstrated survival beyond the perinatal period.

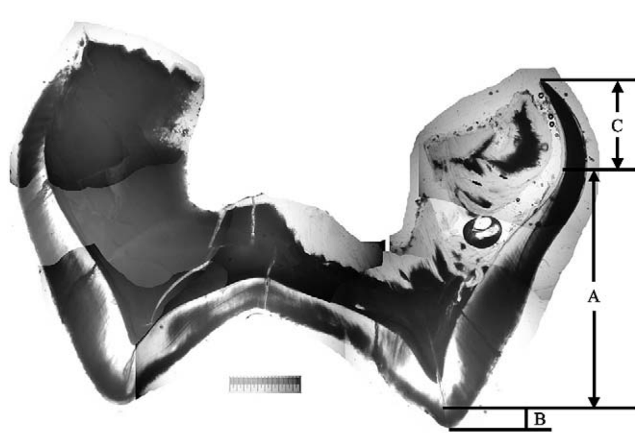

Fig. 1. Ground section of upper first deciduous molar showing measurements taken. A = crown height at birth, B = postnatal enamel formed on occlusal surface, C = extent of apical growth of enamel after birth.

3. Results

The neonatal line could be identified on all specimens with crown height greater than 3.6 mm. In the larger tooth germs, crown height at birth estimated from the neonatal line averaged 3.5 mm. Figs. 2 and 3 show the location of the neonatal line in relation to crown height in two specimens. The distance between the most coronal limit of the neonatal line and its junction cervically with the DEJ corresponded to 3.5 mm. It was present in all tooth germs for which crown height was greater than 3.5 mm. Since these infants survived the perinatal period they presumably represent crown height in the larger full term births. Table 1 gives the frequency distribution of molar tooth height in the upper first molar tooth germs from Ashqelon and Dor. The frequency distribution for both samples peaked at 3.5 mm. This corresponds to the mean value quoted in the literature for full term infants and is consistent with our values calculated from the neonatal line on the ground sections. However, the ratio of young to older individuals differed between sites. At Ashkelon 78.5% of infants had crown length of less than 3.5 mm, indicating that they were less than one week old and the largest tooth germ found was 4.04 mm indicating an age of less than one month. At Dor, only 38.4% of infants were aged less than one week, and nearly 50% were aged more than one month. The age distribution between the two sites was significantly different ($P < 0.01$) using chi-square with Yates correction for small samples. The observed age distribution at each site differed from that reported for census data from the United States in 1922 [43]. This was chosen as a control since it was detailed but carried out before the advent of modern medical treatment. It was therefore considered more reliable as a standard for comparison with archaeological data than present day surveys, where modern treatment in some countries and lack of accurate recording in others, especially when combined with widespread disease and mass starvation, affect census data [46].

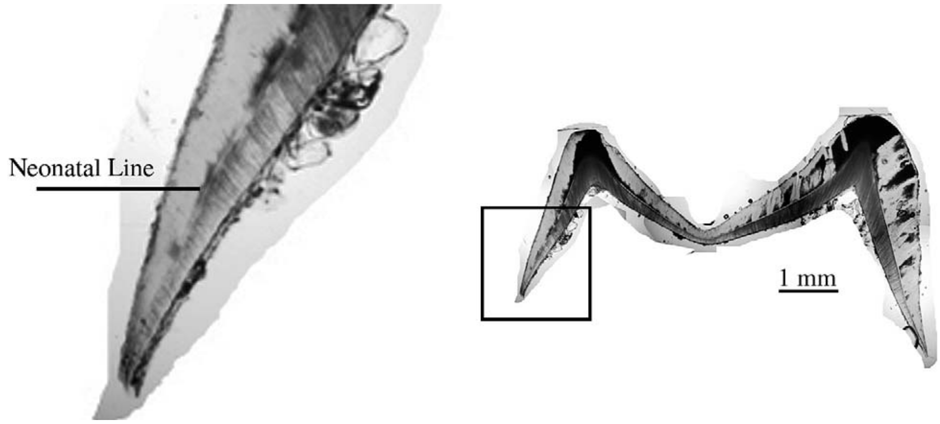

Fig. 2. Thin section of upper first deciduous molar of infant that died soon after birth, showing the neonatal line and small amount of postnatal enamel. Note that the enamel and dentin at the base crown taper to a thin line.

4. Discussion

At the present time, death from natural causes shows an asymmetric age distribution with the greatest frequency of deaths occurring in the perinatal period [21,33,46]. In all societies birth defects and trauma account for most cases of perinatal death. Maternal health, age, occupation, number of prior pregnancies, socio-economic status and access to health care are some of the many factors affecting survival of infants and children. Surveys indicate that as many as 50% of children die before the age of 15 years in some developing countries, with the highest mortality in the first week of life. In the Western world mortality in infancy and childhood is much less, but despite improved medical care and nutrition, the first week of life remains the most critical, with most infant deaths occurring in this or the second week [33]. A recent study carried out on infant mortality in the United Arab Emirates provides dramatic evidence of the contribution of modern medical treatment to the survival of low birth weight infants. The researchers studied infant mortality in three hospitals. They concluded that facilities for treating low birth weight infants even in the absence of other postnatal care contributed to a reduction of 20% in infant mortality over a 10 year period [6].

In past societies we may assume that, as at present, in the absence of neonatal care, few low birth weight infants survived and that the frequency of such births varied with the same factors noted today, primarily maternal health, weight, age and number of previous pregnancies. Assuming that all infants born alive were buried and assuming a minimum frequency of 20% low birth weight infants with little chance of survival, the age distribution of past societies should be biased with

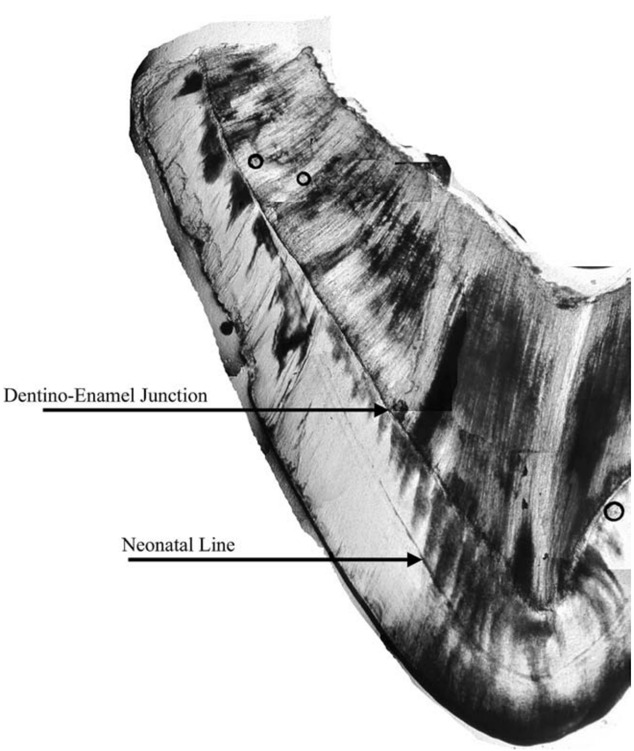

Fig. 3. Thin section through the mesio-buccal cusp of an upper first deciduous molar of an older individual, photographed at ×10 magnification, showing the neonatal line and thick layer of postnatal enamel. The base of the crown has been broken off.

Table 1
Age distribution of infants identified from upper first deciduous molar crown length

Age	Tooth size (mm)	Ashkelon (no. = 14) (%)	Dor (no. = 13) (%)	Expected age[a]
Birth	<3.5	50.0	15.4	26.92
<7 days	<3.7	78.5	38.4	52.35
<1 month	<4.04	100	53.78	71.92
<3 months	<4.8	0	84.7	80.62
<6 months	<5.8	0	100	100

[a] Expected age distribution is based on Steuart [44].

a high frequency of apparently 'fetal' remains using standard aging techniques. If stillborn infants were included this bias would increase even further. However, comparison of age profiles from cemetery populations or Parish records from historic periods with modern census data indicates that many stillborns and/or the infants who died early were not formally buried nor were their deaths reported (Table 2).

The Arikara Amerindian Larsen cemetery sites in the United States are among the few to show an infant age distribution that conforms to the pattern expected in the event of death from natural causes. At this site, where life expectancy was exceptionally low from starvation and disease, Owsley and Bass [29] identified 338 children aged 0–4 years with the vast majority (76%) aged less than 1 year. Owsley and Jantz [30] reported that the frequency distribution of femur length in the size range of >61 cm to 85 cm differed over time. The median value of femur length in modern full term infants is 76 cm long [11]. In the early post-contact period 33.8% of the Arikara infant femora measured less than this, compared to 57% in the later period when conditions had deteriorated even further [30]. Assuming that the highest frequency of deaths occurred in the perinatal period, this suggests a significant decrease in weight of infants born between the two phases. In the earlier period this occurred in infants with femurs averaging 76.5 cm long and in the later period in infants with femurs 73.5 cm long. The 3 cm difference corresponds to a difference of two weeks in their estimates of mean gestational age, and was attributed to deteriorating socio-economic conditions. This study emphasizes the problems encountered in using age estimations based on femur length to estimate postnatal survival.

Gowland and Chamberlain [14] attempted to compensate for the innate variation in age estimations based on long bone length by using Bayesian probability theory based on estimates of the distribution of femur length at different gestational ages in modern Western populations. However, while this method may provide an improved level of confidence for age estimations of large samples of modern Western populations, the examples given above indicate that it may not be appropriate for archaeological samples. Neither does it distinguish between stillborn infants, deaths in the perinatal period and those occurring later in infancy. The neonatal line provides an accurate population specific standard with which to distinguish between perinatal death and later survival.

The histological preparations used here showed no differences in degree of preservation of the mineralized tissues and clarity of the neonatal line, despite the 1400 years separating the two samples. The relation of crown height to neonatal line was similar in both groups, emphasizing the validity of this approach for precise aging and determination of postnatal survival. The number of tooth germs for whom crown height could be measured was small, but indicates significant differences in age distribution between infants from Ashkelon and those from Dor. For Dor, the age distribution is similar to that observed for cemetery populations from other periods in the region where primary burial was practiced. If we assume that these data are typical of age biases in burial practices over time, then with

Table 2
Infant mortality between birth and 4 years

Period	Site	Data from	N	% of 0–1 year	% of 1–4 years
Cemetery					
18th Century	Dor[a]	Unpublished	43	30	70
10th–6th Century BC	Akhziv[a]	Unpublished	150	18.5	87.5
11th–12th Century	Serris[a]	Guy et al. [17]	204	31.86	68.14
11th–12th Century	Fiad-Kerpuszta[a]	Guy et al. [17]	320	59.06	40.94
18th Century	Larsen, Dakota[a]	Owsley and Bass [29]	621	76	24
18th Century	Spitalfields[a]	Molleson and Cox [28]	389	53.62	46.37
Historical records					
16th–19th Century	France[b]	Guy et al. [17]	474	62.44	37.56
18th Century	St. Maclou[b]	Guy et al. [17]	490	51.22	48.78
Recent census data					
1995	Australia[c]	WHO tables	*	79.87	20.13
1997	Canada[c]	WHO tables	*	80.9	19.10
1995	Brazil[c]	WHO tables	*	86.27	13.73
1995	Costa Rica[c]	WHO tables	*	84.98	15.03
2000	Egypt[c]	WHO tables	*	74.59	25.41

[a] Data from archaeological sites.
[b] Data from Parish records.
[c] Data from national censuses [45].
* Calculated from total population. Sample size > 100,000.

reference to epidemiological standards the expected age distribution of infants buried in a separate location, as at Ashkelon, should show a much wider age distribution than was found. The extremely narrow age distribution at Ashkelon established by this study agrees with age estimates previously published for this sample based on long bone length and is considered indicative of infanticide [10,39].

The results obtained here support previous studies carried out on the infants from Ashqelon using long bone length. In these studies bone length showed an extremely narrow range, a finding that was taken to indicate a similar age at death of infants that had developed normally [39,10]. It does not match that expected for natural mortality neither does it show the age distribution expected for infants excluded from the public cemetery because of their age. We propose that the use of the neonatal line, as described here, provides a population specific standard against which to assess perinatal survival in infant remains recovered from archaeological contexts and provides a robust method with which to check age estimations based on other parameters such as crown size or long bone length.

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References

[1] G. Avishai, P. Smith, The cremated infant remains from Carthage: skeletal and dental evidence for and against human sacrifice, American Journal of Physical Anthropology Supplement 34 (2002) 39.

[2] N. Barley, Dancing on the Grave, Encounters with Death, Abacus, London, 1997.

[3] L. Bondioli, R. Macchiarelli (Eds.), Osteodental Biology of the People of Portus Rome (Necropolis of Isola Sacra 2nd–3rd Century AD), Digital Archives of Human Paleontology 1 and 2, E-Lisa Sas Milano, 1999.

[4] S. Brown, Late Carthaginian Child Sacrifice and Sacrificial Monuments in their Mediterranean Context, ASOR Monograph Series No. 3, Sheffield Academic Press, Sheffield, 1991.

[5] L.E. Davidson, H.D. Rodd, Interrelationship between dental age and chronological age in Somali children, Community Dental Health 18/1 (2001) 27–30.

[6] A. Dawodu, M. Varady, M. Verghese, L. Al-Gazali, Neonatal audit in United Arab Emirates: a country with a rapidly developing economy, Eastern Mediterranean Health Journal 6 (2000) 55–64.

[7] D. Deutsch, E. Pe'er, Development of enamel in human fetal teeth, Journal of Dental Research 61 (1982) 1543–1551.

[8] D. Deutsch, O. Tam, M.V. Stack, Postnatal changes in size, morphology and weight of developing postnatal deciduous anterior teeth, Growth 49 (1985) 202–217.

[9] R. De Vaux, Studies in Old Testament Sacrifice, University of Wales Press, Cardiff, 1964.

[10] M. Faerman, G. Kahila Bar-Gal, D. Filon, C.L. Greenblatt, L. Stager, A. Oppenheim, P. Smith, Determining the sex of infanticide victims from the Late Roman era through ancient DNA analysis, Journal of Archaeological Science 25 (1998) 861–865.

[11] I.G. Fazekas, F. Kosa, Forensic Fetal Osteology, Akedemiai Kiado, Budapest, 1978.

[12] F. Fedele, G.V. Foster, Tharros: ovicaprini sacrificali e ritu ale del tophet, Revisti di Studi Fenici 17 (1988) 30–45.

[13] N. Finlay, Outside of life: traditions of infant burial in Ireland from cillin to cist, World Archaeology 31 (2000) 407–422.

[14] R.L. Gowland, A.T. Chamberlain, A Bayesian approach to ageing perinatal skeletal material from archaeological sites: implications for the evidence for infanticide in Roman-Britain, Journal of Archeological Science 29 (2002) 677–685.

[15] M. Gras, P. Rouillard, P. Teixidor, The Phoenicians and death, Berytus 39 (1991) 127–176.

[16] G. Gustafson, Forensic Anthropology, Staples Press, London, 1966.

[17] H. Guy, C. Masset, C.A. Baud, Infant taphonomy, International Journal of Osteoarcheology 7 (1997) 221–229.

[18] H.J. Hoffman, C.R. Stark, J.R. Lundin, J.D. Ashbrook, Analysis of birth weight, gestational age and fetal viability, US births 1968, Obstetrical and Gynecological Survey 29 (1974) 651–681.

[19] B.S. Kraus, Differentiated calcification rates in the human primary dentition, Archives of Oral Biology 1 (1959) 133–144.

[20] B.S. Kraus, R.E. Jordan, The Human Dentition Before Birth, Lea and Febiger, Philadelphia, 1965.

[21] H.O. Lancaster, Expectations of Life, Springer Verlag, New York, 1990.

[22] W.L. Langer, Infanticide: a historical survey, History of Childhood Quarterly 1 (1974) 353–367.

[23] E. Lipinski, Sacrifices d'enfants a Carthage et dans le monde semitique oriental Studia, in: E. Lipinski (Ed.), Phoenicia VI Carthago, Uitgeverij Peeters, Leuven, 1988, pp. 151–162.

[24] E. Lipinski, Dieux et Deesses De L'Univers Phenicien et Punique, Studia Phoenicia XIV, Uitgeverij Peeters and Department Oosterese Studies, Leuven, 1995.

[25] H. Liversidge, M.C. Dean, T.I. Molleson, Increasing human tooth length between birth and 5.4 years, American Journal of Physical Anthropology 90/3 (1993) 307–313.

[26] S. Mays, Infanticide in Roman Britain, Antiquity 67 (1993) 883–888.

[27] S. Mays, M. Faerman, Sex identification in some putative infanticide victims from Roman Britain using ancient DNA, Journal of Archaeological Science 28 (2001) 555–559.

[28] T.I. Molleson, M. Cox, The Spitalfields Project, vol. II, The Anthropology, CBA Research Report, Council for British Archaeology, 1993, pp. 93–209.

[29] D.W. Owsley, W.M. Bass, A demographic analysis of skeletons from the Larson site (39WW2) Walworth County South Dakota: vital statistics, American Journal of Physical Anthropology 51/4 (1979) 145–155.

[30] D.W. Owsley, R.L. Jantz, Long bone lengths and gestational age distributions of post-contact period Arikara Indian perinatal infant skeletons, American Journal of Physical Anthropology 68/3 (1985) 321–328.

[31] F. Padel, The Sacrifice of Human Being, Oxford University Press, Oxford, 1995.

[32] R. Philpott, Burial Practices in Roman Britain, British Archaeological Reports, British Series 219, Archaeopress, Oxford, 1991.

[33] S.H. Preston, M.R. Haines, Fatal Years, Princeton University Press, Princeton, 1991.

[34] J.H. Schwartz, The tophet and "sacrifice" at Phoenician Carthage, an osteologists perspective, Terra 28/2 (1989) 17–25.

[35] J.H. Schwartz, Human sacrifice at Punic Carthage? American Journal of Physical Anthropology Supplement 34 (2002) 137–138.

[36] W.K. Seow, Oral complications of premature birth, Australian Dental Journal 31 (1986) 23–29.

[37] R.P. Shellis, Variations in growth of the enamel crown in human teeth and a possible relationship between growth and enamel structure, Archives of Oral Biology 29 (1984) 697–705.

[38] M. Skinner, T. Dupras, Variation in birth timing and location of the neonatal line in human enamel, Journal of Forensic Sciences 38/6 (1993) 1383–1390.

[39] P. Smith, G. Kahila, Identification of infanticide in archaeological sites: a case study from the Late Roman–Early Byzantine periods at Ashkelon, Israel, Journal of Archaeological Science 19 (1992) 667–675.

[40] P. Smith, T. Zagersen, P. Sabari, J. Golden, T.E. Levy, L. Dawson, Death and the sanctuary: the human remains from Gilat, in: D. Alon, T.E. Levy (Eds.), Archaeology, Anthropology and Cult – The Sanctuary at Gilat (Israel), Leicester University Press, London, in press.

[41] P. Smith, B. Peretz, Hypoplasia and health status: a comparison of two lifestyles, Human Evolution 1 (1986) 535–544.

[42] L.E. Stager, Carthage a view from the tophet, in: H.G. Niemeyer (Ed.), Phonizier im Western, Madrider Beitrage 8, pp. 155–166.

[43] L.E. Stager, S.R. Wolff, Child sacrifice at Carthage, religious rite or population control? Biblical Archaeology Review 10 (1984) 30–51.

[44] W.M. Steuart (Director), Birth, Stillbirth and Infant Mortality: Statistics for the Birth Registration Area of the United States Eighth Annual Report, Department of Commerce, Washington, USA, 1922.

[45] D.K. Whittaker, D. Richard, Scanning electron microscopy of the neonatal line in human enamel, Archives of Oral Biology 23 (1978) 45–50.

[46] World Health Organization, World Health Statistics Annual. WHO Statistical Information System, 1999. http://www3.who.int/whosis/menu.cfm.