Volume 54(2):93-98, 2010
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

ARTICLE

Evidence of surgical trephinations in infants from the 7th-9th centuries AD burial site of Kiskundorozsma-Kettőshatár

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ABSTRACT The authors found 3 infant skulls with cranial lesions in the 7th-9th centuries AD (Avar Age) burial site of Szeged-Kiskundorozsma-Kettőshatár. The remains were examined with standard macromorphological methods of bioarcheology. The most presumable diagnosis of the lesions is surgical trephination. Infants and Avar Age findings were formerly underrepresented in the otherwise abundant and internationally significant amount of paleopathological cases with cranial interventions found in Hungary. Thus, these findings may alter the assumption we formerly had of the cranial surgery of the Avars. During the search for trephined lesions, signs of severe inflammation of the meninges were found in one case and slight hydrocephalus occurred in another implying possible skeletal tuberculosis that put forward interesting questions in connection with healing practices and believes of this era. Together with other Avar Age findings formerly known from the nearby areas these results refine our knowledge of Avar Age medical practices and also the general picture of the medical history of the Carpathian Basin.
Acta Biol Szeged 54(2):93-98 (2010)

KEY WORDS

surgical trephination
infants
Avar Age
tuberculosis
paleopathology

Surgical trephination is a traditional curing and/or ritual custom of long history, during of which all three layers of the cranial vault are intentionally removed in a certain area of the human skull (Aufderheide and Rodríguez-Martín 1998; Ortner 2003). First evidences had been found in Mesolithic layers (Lillie 1998; Crubézy et al. 2001), but it was cultivated in all historical periods and it is still being used in some areas of the world. Though the signs of such lesions are scarce in the bioarcheological material, a lot of trephined skulls had been found in the today area of Hungary (Bartucz 1966; Nemeskéri et al. 1965). Comprehensive data collection in the available archeological (Grynaeus 1996; Tomka 2000) and biological data (Józsa and Fóthi 2007a) have only been performed in the recent past, but our picture of this custom is far from complete. The majority of these cases are connected to adult males among pagan and Christian Hungarians while children and some ethnic groups (and historical periods) like the Avars were underrepresented in these samples. The authors found 3 infant skulls with cranial lesions in the Avar Age (7th-9th centuries AD) burial site of Szeged-Kiskundorozsma-Kettőshatár, where the most presumable diagnosis is surgical trephination. The analysis of these lesions is extremely important and not only on a national level. The international scientific audience knows very little about the diverse spectrum of cranial interventions found in Hungary since only very little information has been made accessible for non-Hungarian scholars so far (Pálfi 1997; Aufderheide and Rodríguez-Martín 1998; Grynaeus 1999; Arnott et al. 2003; Bereczki and Marcsik 2005; Szathmáry and Marcsik 2006; Józsa and Fóthi 2007b).

Accepted Dec 14, 2010
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Materials and Methods

The Avar Age cemeteries of Szeged-Kiskundorozsma-Kettőshatár were excavated in 2004 by archeologists Patrícia Mészáros, Tibor Paluch and Csaba Szalontai (Mészáros et al. 2006) in a series of rescue excavations performed along the construction site of highway M5, northwest of the city of Szeged at the southern border of Hungary. The site is dated to the 7th-9th centuries AD. In that time, the flat area was divided by several smaller watercourses, temporary and permanent lakes, and was regularly affected by the flood of the river Tisza. The site is located on top of a slight, long elevation. The cemetery of Kiskundorozsma-Kettőshatár I consisting of 298 burials is dated from the end of the 7th to the beginning of the 9th century AD. Based on the chronology and the archeological observations it is very likely that the graveyard was used by the same population that used the nearby Kiskundorozsma-Daruhalom II cemetery in the former period. The graveyard is not completely excavated as some parts of it are situated further away from the path of highway M5. Kiskundorozsma-Kettőshatár II lies 60 m away from the first cemetery, consists of 43 graves and was used at the end of the 8th century AD. Though this cemetery is separated from Kiskundorozsma-Kettőshatár I, it may have been used by the same population. The site is fully excavated, most of the graves were robbed presumably in a single occasion by contemporary robbers, hardly any skeletons were recovered

Figure 1. obj. 263, 8-11 years old child, skull.

Figure 2. obj. 263, 8-11 years old child, surgical trephination.

in anatomical position. The remaining grave goods refer to an upper class burial site. The remains of altogether 360 individuals were recovered in the two cemeteries (121 subadults, 239 adults (130 males, 109 females)) (Marcsik et al. 2010). Comprehensive bioarcheological investigation of the remains is in progress at the Department of Biological Anthropology, University of Szeged. Preliminary results of these analyses have already been published (Molnar et al. 2006; Marcsik et al. 2009; Marcsik et al. 2010). During the paleopathological data collection in the Kiskundorozsma-Kettőshatár I series we came across 3 infant skulls with holes in the cranial vault that seemed to have been created *intra vitam*. Age at death was determined using standard macromorphological methods (Schour and Massler 1941; Schinz et al. 1952; Stloukal and Hanáková 1978; Knussmann 1988; Ubelaker 1989). The

Figure 3. obj. 263, 8-11 years old child, patches of trabecular new bone in the endocranial surface of the frontal bone.

skeletal material is housed in the Department of Biological Anthropology, University of Szeged, Hungary.

Results

Obj. 263 (A. P. 562), 8-11 years old child

The *post mortem* moderately deformed skull (Fig. 1) and the mandible are well-preserved, the postcranial elements are mostly missing. The elongated lesion (Fig. 2) is located in the left side of the coronal suture, 35 mm from the sphenofrontal suture. The hole is kidney-shaped, 26 mm at the biggest and 11 mm at the smallest diameter. The edges are mostly vertical and slightly rounded showing considerable healing. A secondary cortical bone layer is covering the exposed spongious part. The mid section of the anterior rim is flat inclining towards the center of the lesion with irregular edges. At the antero-inferior part some remnants of the exposed spongious bone structures are still visible. The inferior part is *post mortem* damaged.

The endocranial surface is strongly affected by different forms of new bone formation. The frontal bone is the most severely affected. The internal cortex of the upper half of the squama is thickened, the surface is irregular. Approx. 2 cm wide patches of trabecular new bone layer were formed in the middle of the squama and in the proximity of bregma (Fig. 3). The patches include small blood vessel impressions too. Similar but less severe lesions can be seen near the right side of the coronal suture both on the frontal and the right parietal bone. Near the bregma and the elongated aperture a few small tuberculi also appear in the size of 2-4 mm. The most of the parietals' internal surface is covered by fine groups of thin vessel impressions.

Some of the teeth show moderate signs of linear enamel hypoplasia (LEH) referring to a chronic stress condition of unknown origin possibly between the 3rd and 5th years of life.

Figure 4. Obj. 491, 2-3 years old child, skull.

Figure 5. Obj. 491, 2-3 years old child, surgical trephination.

Obj. 491 (A. P. 654), 2-3 years old child

The skull (Fig. 4) and the mandible is well-preserved, a lot of postcranial elements are missing. A regular round hole can be seen in the anterior part of the right parietal (Fig. 5) 17 mm from the coronal suture and 35 mm from the sagittal suture. The external diameter is 11x9 mm, the internal is 7x6 mm, the aperture is getting wider towards the outer surface. The lateral edge of the lesion is almost vertical, the medial edge is somewhat less steep. Each possible section of the rim shows plain edges, with only moderate remodelling of the cortical layer, thus, the exposed spongious layer of the bone is still visible.

The shape of the head is very unusual, extremely oblong and slightly cubic. Other pathological signs are not present.

Obj. 537 (A. P. 694), 11-13 years old child

The remains of the skull (Fig. 6) are *post mortem* severely deformed and moderately preserved. Postcranial elements are present but the thorax and the distal parts of the upper extremities are mostly missing. Despite the young age, the bones show masculine characteristics, the remains may be those of a boy.

Almost in the midline of the frontal squama, slightly towards the right side, 30 mm above the right orbit a 22x16 mm ovoid hole is found (Fig. 7). The otherwise vertical edges and the surroundings of the lesion on both cortical surfaces are heavily eroded, no sign of remodelling is visible. The aperture widens towards the internal surface on the superior part.

Clear signs of a healed depressed fracture can be seen in the upper medial corner of the left orbit (Fig. 8) on the frontal sinus. The depression is 14x13 mm in size and slightly almond shaped with an 8 mm irregular, partly healed-partly damaged aperture in the middle. Most possibly connected to this trauma, a rounded bony flake protrudes from the upper medial wall of the left orbit that may have covered a blood vessel.

Figure 6. Obj. 537, 11-13 years old child, skull.

Slight bilateral porotic cribra orbitalia and LEH is also present in the skull referring to some unknown chronic stress condition in earlier life. LEH dates back to approx. the 3rd-5th years of life.

Figure 7. Obj. 537, 11-13 years old child, surgical trephination.

Figure 8. Obj. 537, 11-13 years old child, healed depressed fracture at the left orbit.

Discussion

Surgical trephinations of different state of preservation and healing can be mistaken for different forms of trauma, tumorous, infectious, inflammatory, etc. conditions, developmental defects like meningioceles and even *post mortem* alterations (Aufderheide and Rodríguez-Martín 1998; Ortner 2003; Bennike 2003). In the case of obj. 263, the clearly defined edges are mostly covered by secondary cortical bone that implies a longer period of survival of the intervention and healing. Developmental protrusion of soft tissue of any kind is not likely when the edges of the lesion are so different from each other as in this case. Meningioceles usually appear in former sites of fontanelles (Bennike 2003) and along the midline sutures (Khan et al. 2010) none of which applies for the current case. In addition, despite the moderate healing the posterior rim still shows the original plains of the cut. This hole is most probably a surgical trephination, the etiology of which becomes clearer with the interpretation of other lesions of the skull.

The endocranial lesions refer to a severe, active pathological condition that may have played a role in the death of the infant. The paleopathological occurrence of blood vessel impressions, irregular thickening and trabecular, fibrous new bone layers can be indicatives of meningitis of various origin, but lately these were observed to be frequently associated with inflammatory processes induced by mycobacterial infection too (Hershkovitz et al. 2002; Pálfi 2002; Maczel 2003). The new bone structures of this skull may be results of severe meningitis as a reaction to invasion of human pathogen mycobacteria (*Mycobacterium tuberculosis*-complex) developing symptoms of CNS TB (central nervous system tuberculosis) which have currently been reported to appear also in contemporary patients (Khoo et al. 2003; Corr 2008; Di Carlo et al. 2008) based on radiological imaging results.

Surgical trephinations are usually induced by blunt trauma, after which a need occurs for artificial smoothing of the edges of the fracture site in order to facilitate faster healing and closure of the wound (Szathmáry 1982; Aufderheide and Rodríguez-Martín 1998; Ortner 2003). In most of the cases the healed lesions do not exhibit signs of the original trauma as the damaged bony units are cut out in the course of the trephination (Szathmáry 1982; Józsa and Fóthi 2007a). This may be case for obj. 263 too. However, it is also possible that the trephination and the endocranial lesions are connected. Thick, remodelled endocranial lesions and the semi-healed rims of the trephine also take several weeks to develop. The hole may have been created within the duration of the inflammatory process because of a belief that otherwise successful surgical interventions (normally applied to heal trauma) can also help health problems that are not related to trauma. This latter phenomenon was observed among contemporary tribal populations too (Ella 1874; Bartucz 1966; Szathmáry 1982). The endocranial lesions though, may derive from a posttraumatic infection too (either the primary trauma or the correction trephination), or even a non-mycobacterial infection not connected to the trauma episode.

The aperture found on the skull of obj. 491 is the most definite case of surgical trephination among the three. The plains of the circular cut are clearly visible despite the early-stage healing. On the other hand, the cause of intervention here, however, is the least obvious among our findings. According to Józsa and Fóthi (2007a) some of the weapons used

in the Middle Ages had so thin pointed parts that may have caused severe but very little traumatic lesions on skulls. These wounds do not show signs of the inducing trauma after they were treated with a correction trephination. In our case, however, the trephination itself is so small that such an inducing trauma is unlikely. The shape of the head provides the only possible clue, resembling hydrocephalus which again, can be caused by many primary illnesses from inflammations of infectious origin to metabolic deficiencies and developmental anomalies (Aufderheide and Rodríguez-Martín 1998; Ortner 2003; Corr 2008). This almost punctured surgery may have been used to treat symptoms of this disease – either by decreasing intracranial pressure that might have caused headache because of the increased volume of subarachnoid fluid, or only because of the believes mentioned in the interpretation of obj. 263.

The most classical trauma etiology occurs in the case of the lesions of obj. 537. The skull is moderately preserved, and the hole on the frontal bone does not provide enough information on its own because of the damaged surfaces of the rim and the surrounding ecto- and endocranial areas. The healed depressed fracture on the left side of the frontal sinus, however, helps to shed light on the origins of the trephination. The depressed fracture and the wound that required correction (trephination) may have originated from the same episode of trauma. There is also a probability that the trephined area underwent a posttraumatic infection as some porosity possibly related to inflammatory hypervascularisation is clearly visible in the nearby outer surface just like in the case of the surgical trephination of Hódmezővásárhely-Nagysziget grave no. 55 mature female skull (Bereczki and Marcsik 2005). Unfortunately, this porosity cannot be undoubtedly attributed to *intra vitam* processes, and other signs of a possible septic inflammation can also not be detected because of the *post mortem* changes of the area. Cribra orbitalia and LEH observed in this case are, of course, not necessarily connected to the trauma and the possible surgical intervention, as both phenomena must started developing before the lesions of the frontal bone.

All three trephinations may have been prepared with fine cutting movements with sharp-bladed tools, as in most of the cases of the 9th-11th century AD Hungarian material (Szathmáry 1982). The method of operation, however, can only be surely identified in the case of obj. 491, since healing (obj. 263) and diagenesis (obj. 537) obstructs the observation.

The description and analyses of trephined remains do not follow a commonly accepted set of aspects and uniform way of publication of the results in the Hungarian literature as Józsa and Fóthi (2007a) pointed out. We still lack the necessary amount of information to interpret the history of cranial surgery in Hungary with accuracy. Furthermore, Avar Age trephinations are rare in the records. Tomka (2000) only cites 10 trephined skulls from the Avar Age, while Józsa and Fóthi (2007a) mention 13 surgical interventions from this era among 130 trephined skulls found in the Carpathian Basin. 10 of these Avar cases are adult males and 3 adult females. According to our assumption, two of these cases are definitely *perimortem* lesions (Kiskőrös) possibly not performed for medical but purely for ritual reasons. In the south-eastern part of Hungary Józsa and Fóthi (2007a) only cite 5 Avar Age skulls with surgical trephination (Szeged-Fehértó, Szeged-Kundomb, Szőreg, Nagykamarás, Vedresháza) all of which belonged to adult males. In their total sum of 130 skulls they only found 11 cases with unidentified sex. As no differentiation is available between infants and adults with undetermined age at death within this number, we can only presume that currently there are less than 11 cases of surgical trephinations known in subadult subjects, and Avar Age infants are definitely not part of the sample.

Thus, our findings considerably increase the number of surgical trephinations from the Avar Age and they have no parallels so far within this era in the sense of age at death of the subject. In the case of obj. 491 the size of the lesion is also unique. We can only compare our data to results of the nearby Avar Age excavations in the north of Serbia. Czékus (2007) found a lesion on the skull of Stara Moravica grave no. 90 (approx. 65 yrs male, moderate healing) similar in size (9 mm) to that of obj. 491. Lovász (personal communication) found a trephined skull fragment belonging to an approx. 2.5 years old child in grave no. 51 of Bački Sokolac (moderate healing). Further Avar Age cases in the surroundings are found in the Bélmegyer-Csömöki-domb cemetery (grave no. 27, 40-50 yrs male, minor healing (Józsa 1990) and in the Maroslele 24 site (KÖH 38672) (grave no. 1, 18-22 yrs female, no healing (Paja and Pópity personal communication). The number of Avar Age surgical trephination has virtually doubled with the new findings (five to ten) in the southeastern part of the Great Hungarian Plain. Based on these data have to assume that the Avar Age population of the area was more familiar with the practice of surgical trephination than we thought it before. It is possible that all the mentioned cases belong to the heritage of a distinct local trepanning tradition.

In order to see how frequent surgically trephined remains are in the Avar material we performed a basic inventory analysis and compared the data of the Avars with that of the early Hungarians. Our department has analyzed remains of 8109 Avar Age (6th-9th century AD) individuals and among them 10 trephined skulls were found (0.12%). Conquering Hungarians (9th-10th century AD) are represented with 1430 individuals and 12 trephined skulls among them (0.84%). Árpád Age findings sum up to 3883 individuals where 11 trephined skulls can be recorded (0.28%). The early Hungarians still provide the overwhelming majority of the trephination cases in the southeastern part of the Great Hungarian Plain as it was already mentioned by other scholars (Grynaeus 1996; Tomka 2000; Józsa and Fóthi 2007a). With the new Avar findings

the advantage of the Hungarian skulls is not bigger by one order any more, especially when Avar data are compared to the Árpád Age series.

Concluding we can say that the new findings considerable increased the number of known cases with surgical trephination from the Avar Age both on the local and on the national level. Young age at death for trephined individuals is a formerly unknown phenomenon from this historical period. The possible association of TB and other health damaging conditions in these cases require further aDNA and biomarker analyses. On the whole, the remains of these three deceased children open a new window to the medical history of the Avar people.

Acknowledgement

The authors wish to express their gratitude to Gabriella Lovász (Municipal Museum of Subotica, Serbia) for information on archeological sites in Serbia and also Dániel Pópity and László Paja (Center for National Heritage, Hungarian National Museum) for the information on the Maroslele skull. This study was supported by the Hungarian National Research Fund OTKA no. 78555.

References

Arnott R, Finger S, Smith C (2003) Trepanation: History, Discovery, Theory. Swets & Zeitlinger, Lisse, The Netherlands.

Aufderheide AC, Rodríguez-Martín C (1998) The Cambridge Encyclopedia of Human Paleopathology. Cambridge University Press.

Bartucz L (1966) A praehistorikus trepanáció és orvostörténeti vonatkozású sírleletek. Palaeopathologia III, Országos Orvostörténeti Könyvtár, Budapest.

Bennike P (2003) Ancient trepanations and differential diagnoses: a re-evaluation of skeletal remains from Denmark. In Arnott R, Finger S, Smith C (2003) eds. Trepanation: History, Discovery, Theory. Swets & Zeitlinger, Lisse, The Netherlands, pp. 95-115.

Bereczki Zs, Marcsik A (2005) Trephined skulls from ancient populations in Hungary. Acta Medica Lituanica 12:65-69. http://www.ebiblioteka.lt/resursai/LMA/Acta%20medica%20Lituanica/ActM_065_069.pdf

Corr PD (2008) Imaging in CNS Tuberculosis. http://emedicine.medscape.com/article/344862-imaging

Crubézy É, Bruzek J, Guilaine J, Cunha E, Rougé D, Jelinek J (2001) The antiquity of cranial surgery in Europe and in the Mediterranean basin. Comptes Rendus de l'Académie des Sciences – Series IIA – Earth and Planetary Sciences 332:417-423.

Czékus G (2007) Az ómoravicai (Stara Moravica) avar temető csontvázmaradványainak embertani jellemzése. Oral communication – Az MBT Szegedi csoportjának ünnepi ülése Prof. Dr, Farkas L. Gyula tiszteletére 75. születésnapja alkalmából, Szeged. 2007. jún. 29.

Di Carlo P, Cabibi D, Casuccio A, Mazzola A, Romano A, Titone L (2008) Features in Tubercular Meningoencephalitis Diagnosis: 18 Childhood Cases. Am J Inf Dis 4:187-192.

Ella S (1874) Native medicine and surgery in the South Sea island. The Medical Times and Gazette.

Grynaeus T (1996) Isa, por… A honfoglalás és az Árpád-kori magyarság betegségei és gyógyításuk. Fekete Sas Kiadó, Budapest.

Grynaeus T (1999) Skull Trephination In the Carpathian Basin. Mankind Quarterly 40:131.

Hershkovitz I, Greenwald CM, Latimer B, Jellema LM, Wish-Baratz S, Eshed V, Dutour O, Rothschild BM (2002) Serpens Endocrania Symmetrica (SES): A new term and a possible clue for identifying intrathoratic disease in skeletal populations. Am J Phys Anthropol 118:201-216.

Józsa L, Fóthi E (2007a) Trepanált koponyák a Kárpát-medencében. Folia Anthropologica 6:5-18.

Józsa L, Fóthi E (2007b) Trepanált koponyák Magyarországon – 115 eset összesítése. Orvostörténeti Közlemények 198-199:15-30., http://www.ncbi.nlm.nih.gov/pubmed/18175532

Józsa V (1990) Pathologiás elváltozások egy avar kori széria (Bélmegyer-Csömöki-domb) embertani anyagában. Diploma work, József Attila University, Department of Biological Anthropology, Szeged, supervisor: Antónia Marcsik.

Khan AN, Turnbull I, MacDonald S, Sabih D (2010) Encephalocele imaging. http://emedicine.medscape.com/article/403308-overview

Khoo JLS, Lau KY, Cheung CM, Tsoi TH (2003) Central Nervous System Tuberculosis. J HK Coll Radiol 6:217-228.

Knussmann R (1988) Anthropologie; Gustav Fischer, Stuttgart-New York.

Lillie MC (1998) Cranial surgery dates back to Mesolithic. Nature 391:854.

Maczel M (2003) On the traces of tuberculosis – Diagnostic criteria of tuberculous affection of the human skeleton and their application in Hungarian and French anthropological series. PhD dissertation, UMR 6578 CNRS-University of La Méditerranée, Marseilles – Department of Biological Anthropology, University of Szeged, Szeged, supervisors: Olivier Dutour, Antónia Marcsik.

Marcsik A, Molnár E, Ősz B, Donoghue HD, Zink A, Pálfi Gy (2009) Adatok a lepra, tuberculosis és syphilis magyarországi paleopatológiájához. Folia Anthropologica 8:5-34.

Marcsik A, Pálfi Gy, Márk L, Molnár E (2010) Cases of leproy and tuberculosis in an 8th-9th century cemetery from Hungary. 18th European Meeting of the Paleopathology Association, Program and Abstracts, 23th-26th Aug 2010, 156.

Mészáros P, Paluch T, Szalontai Cs (2006) Avar kori temetők Kiskundorzsma határában. Tatabányai Múzeum Tudományos Füzetek 8:97-109.

Molnár E, Marcsik A, Bereczki Zs, Donoghue HD (2006) Pathological cases from the 7th century in Hungary. 16th European Meeting of Paleopathology Association, Program-Abstracts, 28th Aug-1st Sept 2006, Santorini, Greece.

Nemeskéri J, Kralovánszky A, Harsányi I (1965) Trephined skulls from the tenth century. Acta Arch Hung 17:343-367.

Ortner DJ (2003) Identification of Pathological Conditions in Human Skeletal Remains. Academic Press, San Diego.

Pálfi Gy (1997) Maladies dans l'Antiquité et au Moyen-Âge. Paléopathologie comparée des anciens Gallo-Romains et Hongrois. Bulletins et Mémoires de la Société d'anthropologie de Paris, Nouvelle Séri 9:1-205. http://www.persee.fr/web/revues/home/prescript/article/bmsap_0037-8984_1997_num_9_1_2472

Pálfi Gy (2002) Paleoepidemiological reconstruction of tuberculosis, with particular attention to Europe. In Bennike P, Susanne C eds., Biennial Books EAA 2:193-210.

Schinz HR, Baensch WE, Friedl E, Uehlinger, E (1952) Ossifikationstablelle. In Schinz [et al.] eds., Lehrbuch der Röntgendiagnostik, 5. Auflage Stuttgart, Thieme.

Schour J, Massler M (1941) The development of the human dentition. J Am Dent Assoc 28:1153-1160.

Stloukal, M, Hanáková, H (1978) Die Länge der Langsknochen altslawischer Bewölkerungen unter besonderer Berücksichtigung von Wachstumsfragen. Homo 29:53-69.

Szathmáry L (1982) A bihardancsházi trepanált koponya. BMÉ 3:21-41.

Szathmáry L, Marcsik A (2006) Symbolic trephinations and population structure. Mem. Inst. Oswaldo Cruz 101, suppl.2:129-132. http://memorias.ioc.fiocruz.br/p17.pdf, http://www.ncbi.nlm.nih.gov/pubmed/17308819

Tomka P (2000) Régészeti kommentár a Lébény-Kaszás 10-11. századi temető 44. sírjának trepanált koponyaleletéhez. Arrabona 38:63-89.

Ubelaker, DH (1989) Human skeletal remains: excavation, analysis, interpretation. Taraxacum, Washington, 3rd edition.