Mediterranean Archaeology and Archaeometry, Vol. 16, No.2 (2016) pp. 61-74

DOI:10.5281/zenodo.47543

CRANIAL AND POST-CRANIAL TRAUMATIC INJURY PATTERNS IN VAN CASTLE MOUND MEDIEVAL POPULATION

Ahmet Cem Erkman[1], Okşan Başoğlu[2], Gülüşan Özgün Başıbüyük[3], Pınar Gözlük Kırmızıoğlu[3], Ayhan Yiğit[3], Yarenkür Alkan Yalçın[1], Ferhat Kaya[4]

[1]*Department of Anthropology, Faculty of Arts and Sciences, Ahi Evran University, Kirşehir, Turkey.*
[2]*Department of Archaeology, Faculty of Letters, Gazi University,Ankara, Turkey.*
[3]*Department of Anthropology, Faculty of Letters, Cumhuriyet University, Sivas, Turkey.*
[4]*Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland.*

Received: 11/03/2016
Accepted: 10/04/2016
Corresponding author: cemerkman@hotmail.com

ABSTRACT

The excavations conducted at Van Castle Mound, East Anatolia, between 1987 and 2010 uncovered a total of 328 human skeletons dating back to the Medieval period. Thirty trauma cases were identified within the collection, constituting 9.14% of the entire population. Typology and distribution of the trauma among different sexes indicated that depression fractures, oblique fractures, comminuted fractures, and head deformation were more frequently observed in male skeletons, while a post-fractural infection appeared only in a female skeleton. Trauma cases were more common on post-cranial bones. In addition, a trepanned cranial specimen belonging to a mature individual is identified in which grooving technique was performed. Most of the observed trauma cases were related to heavy labor, unsafe working conditions, and challenges of everyday agrarian life. Previous paleopathological studies from the Medieval Van Castle Mound also indicates an insufficient nutritation and high physical stress.

KEYWORDS: Trauma, trepanation, paleopathology, fracture, Anatolia.

1. INTRODUCTION

Trauma cases has been explained as the fractures and wounds which cause the deformation of the skeletons (Roberts & Manchester, 1995; Ortner & Putschar, 1985; Ortner, 2003). Skeletal remains provide important and common paleopathologic features from ancient to modern times. Complications in social and biological lifetime depending on the cultural and demographic structure have an effect upon trauma variations and helped increase the number of cases (Roberts & Manchester, 1995). Therefore trauma cases can be instrumental in understanding the occupations, material cultures, living environments, demographic structures, ancient-economies, nutritional habits, and cultural traits of a society. We can infer information about social structures including expressions of hostility or violence among individuals and treatment and care conditions of wounded persons. (Judd & Roberts, 1999; Lovell, 1997; Judd 2004; Erdal, 2012).

The study on medieval Van Castle Mound population focuses on the description and distribution of trauma lesions on post-cranial (including femur, tibia, fibula, humerus, ulna, radius, scapula, clavicle and ribs) and cranial remains (including frontal, parietal, occipital, and maxilla) in terms of the frequency of different sex and age groups. Furthermore this study seeks to better understand cultural and individual habits of the medieval Van Castel Mound society by examining the paleopathological and archaeological patterns marked on human skeletal remains.

Anatolia has been a homeland for various cultures and civilizations from prehistoric times to the present day due to its unique geographical position as a crossroads among the continents. Urartians, one of these civilizations, existed between 6th to 9th centuries BC around the Lake Van in eastern Anatolia. Tushpa (Van), the capital of this civilization, was located on the eastern coast of Lake Van. In the center of Tushpa Van Castle sits on top of a conglomeratic rock hill surrounded by the most fertile agricultural plain in the region. The area has a continuous cultural heritage of 2800 years since the 9th century BC through the end of World War I. It was not until 1956 that Burney named this area 'Van Castle' (Tarhan, 1989; Tarhan and Sevin, 1991). Van Castle Mound is located in the north of the castle with the east-west orientation parallel to the citadel (Fig. 1) (Konyar, 2011).

Lake Van, situated on the eastern Anatolian high plateau close to the border to Iran is the fourth largest terminal lake and the largest soda lake on earth. Its water's high alkalinity is caused by high carbonate concentrations, volcanic activities of Nemrut and Suphan mountains, and subaquatic hyrothermal exhalations (Kempe et al., 1991; Kaden et al., 2010). The lake is uniquely located on complex tectonic activity controlled by the collision of Afro/Arabian plate from the south and the Eurasian plate from the north. The regional environment at Lake Van is characterized by a continental climate. It is ubicated at the junction of the westerly jet stream, the extension of the subtropical high pressure system, and the dry continental air masses of NE-Europe and Asia making it climatically sensitive (McCormick et al, 2012). The local climate of Lake Van area shows a strong seasonality with cold winters (December to February) and warm summers (July to September).

2. SITE

The region of Van has been the home of many societies for thousand of years due to its geographical location at the intersection of Anatolia, Middle East and the Caucasians. Depending on the archeological data the history of Van region goes to 15.000 BC (Belli, 1975). Cultural and political history of the region is quite complex; including rapid turnovers of ruling powers. The land from northern Syria to Lake Urmia (including the province of Van) was ruled by Hurrians from 4000 B.C to 2000 B.C. until the control taken over by Urartians from 900 B.C to 600 B.C. (Erzen, 1992; Çilingiroğlu, 1988). Soon Persians marched into the area and their occupation continued between 550 B.C to 331 B.C. Conqueror of the Persian Empire, Alexander The Great, became a new ruler of the area around 331 B.C. Once again after Alexander The Great Van region was dominated by another great empire; Romans. When the Roman Empire collapsed, Van was invaded by Byzantiums and Sassanids. Until the beginning of 7th Century, Van region was ruled by Byzantiums, however between 2nd and 7th centuries Sassanids were in charge. Khazar Turks and Muslim armies attacked periodically to the region since 625 (Erzen, 1992). Van region was ruled by Omayyads until the end of the 7the century. After that, Abbasids took the control of the region until the end of 10th century (Demir, 2004). During the Abbasids rule, there were four different Armenian Kingdoms established in the area; the Kars Bagratlıları (968- 1064), Tasirk Bagratlıları (982-1044), Ani Bagratlıları (885-1045), and on the eastern side of the Van Lake the Ardzruni Principality (908-1021) (Mangaltepe, 2005; Kılıç et al., 2006; Karaca, 1996). Meanwhile, attacks of Turks on Byzantium were increased. Armenian Prince of Waspurakan Senekerim Ardzruni made a deal with the Byzantium Emperor II. Basileios and left the city to the Emperor (Ostrogorsky, 1995). The region was ruled respectively by the Ahlatshahs, Eyyubs, Harezmshahs until the arrival of Seljuks (13th century) (Turan, 1993; Turan, 1996). The Ottomans occupied the area by 15th century until fall of the empire (Kılıç et al., 2006; Mangaltepe, 2005; Turan, 1993-1996; Karaca, 1996).

Van Castle is approximately 1250 m in length, 70–80 m in width, and 100 m in height, and it is situated on conglomerate rock immediately on the eastern shore of Van Lake. Van Castle Mound is placed on the north of the castle and extends in an east-west direction parallel to the citadel. The mound is approximately 750 m in length and comprises the northern part of the famous Urartian capital of Tushpa city (Fig. 1). Van Castle, the area of the Lower City and its surroundings, is the most fertile plain of the region and it was inhabited during the Chalcolithic, Early Bronze Age, Early Iron Age, Middle and Late Iron Ages (Urartian, Median and Persian periods), and medieval period.

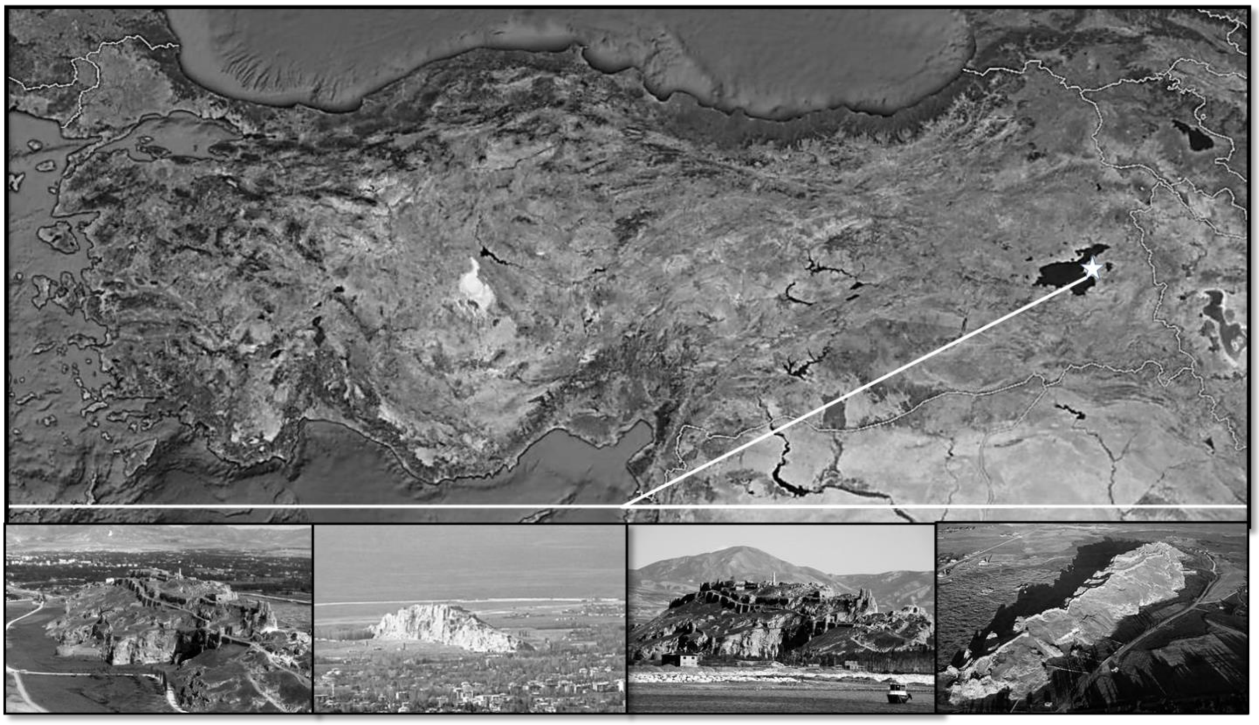

Figure 1: Map showing the location of Van Castle Mound (white star) near the Lake Van in eastern Anatolia, including the views from the castle at the bottom (Erkman & Surul, 2014).

The first archaeological excavations of Van Castel Mound carried out between the years of 1989-1991 under the presidency of the Research Center of History and Archaeology of Van Region (at *Faculty of Letters, İstanbul Universty)* with the scientific responsibility of Prof. Dr. Taner Tarhan. Later, the excavations of Van Castle Mound which was started again under the presidency of Ass. Prof. Dr. Erkan Konyar in 2010. It is still on progress today.

3. MATERIALS

The 328 skeletons included in this study were discovered at the necropolis, in use from the medieval period until the beginning of the twentieth century, and were recovered from excavations that took place between 1987 and 2010. The first portion of the materials, consisting of 145 skeletons, was unearthed by a team directed by Prof. Tarhan and Prof. Sevin. Van Museum management supervised the excavation between 1987 and 1990 (Tarhan & Sevin 1991)(Figure 1). The remaining 183 skeletal specimens were recovered during excavations directed by Asst. Prof. Dr. Erkan Konyar (Konyar, 2011; Erkman & Surul, 2014).

Grave dimensions differ from 0.50m to 1.30m in depth formed in rectangular gutters with rounded corners in clay deposits. Since the graveyards found in the castle are smaller in size than the others it is believed they re-used these graves by adding little more of clay and bury another person on top of the other one. This inlay had extended up to 2m in 1000 years. The skeletal remains are comparatively well preserved when compared with the preservation standards of other archaeological populations found in Anatolia. There are primarily two different grave types (Konyar, 2011):

1. Soil Graves

a) Without Cover Stone

b) With Cover Stone

c) With Cover Stone and Double Pits

2. Cist Graves

a) Stone Cist Grave

b) Mudbrick Cist Grave

The date of the skeletal remains was determined at the *Beta Analytic Radiocarbon Dating Laboratory (Florida)* using a mass spectroscopy method (AMS - Accelerator Mass Spectrometry Radiocarbon Dating). The vertical section of the mound is around 2m thick and samples (10 gr femur head bone collegen) were taken from the indiviudals buried at the bottom and top of the section. The results show that the bottom layer of the graves is dated back to 1070 ± 30BP and upper layers date 120± 30BP, which indicate a time range from 940/1020A.D to 1800/1940 A.D.

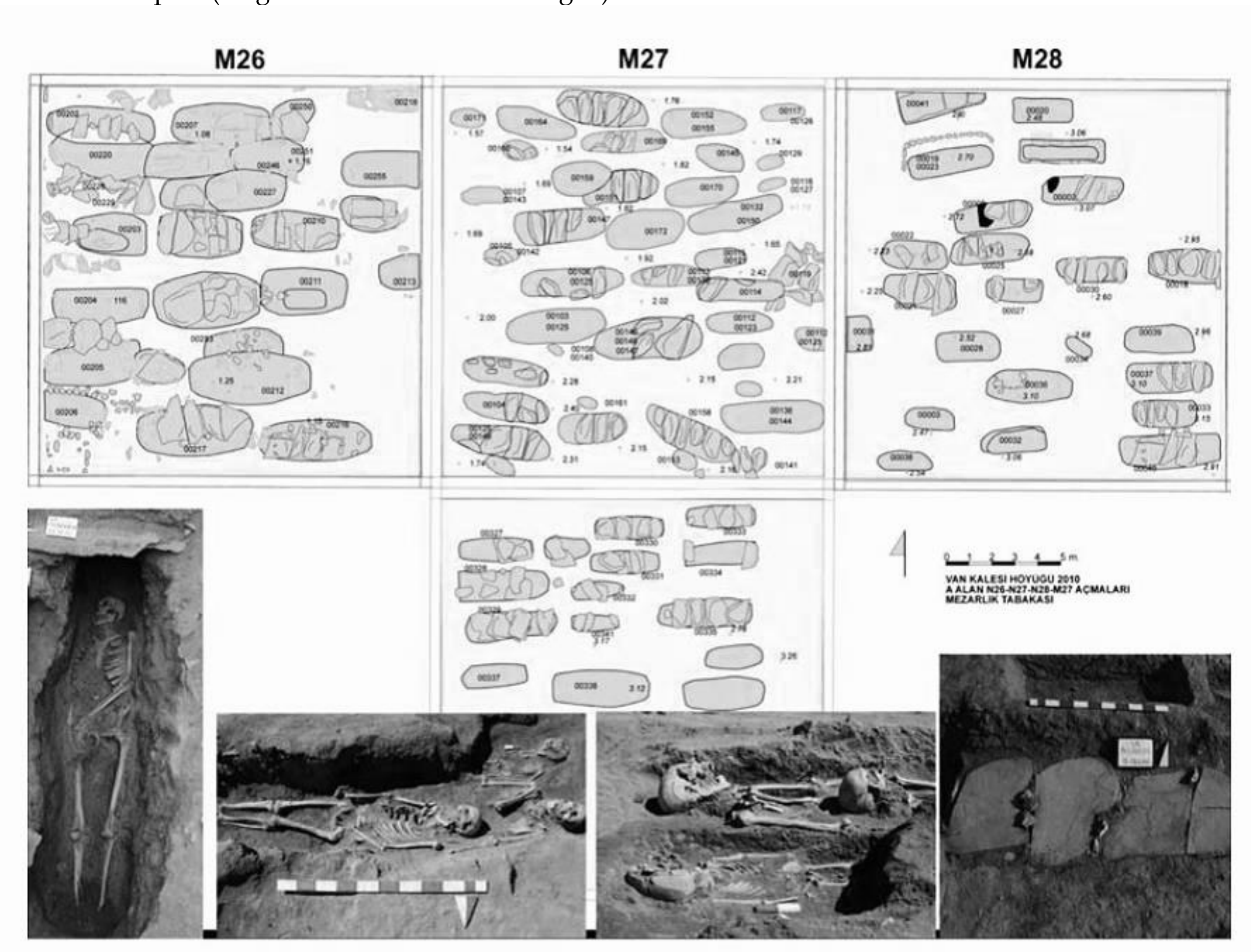

Figure 2: Human burials recovered from the Van Castle Mound (Konyar 2011).

4. METHODS

Sex determination of individuals was primarly based on sexually dimorphic traits of the pelvic bone and skull (Acsadi & Nemeskeri, 1970; Bass, 1979; Brotwell, 1981; Ubelaker, 1978; Buikstra & Ubelaker, 1994; Workshop of European Anthropologist, 1980). No attempt was made to determine the sex of subadults.

Estimation of age at death in adults was determined based on pubic symphysis degeneration (Brooks and Suchey, 1990; Todd, 1920), auricular surface morphology (Lovejoy et al., 1985), and changes on the sternal ends of the ribs (İşcan and Loth, 1984; İşcan et al., 1985). Additionally, cranial suture closure (Meindl and Lovejoy, 1985; Olivier, 1969) assisted with estimation of adult age status. Estimation of age at death in young adults was determined based on fusion of the medial clavicle, fusion at secondary ossification centers (McKern and Stewart, 1957; Scheuer and Black, 2000), rib heads (McKern, 1957; Scheuer and Black, 2000), third molar root mineralization, (Hillson, 1996) and sacral bodies (McKern and Stewart, 1957; Scheuer and Black, 2000).

The degree of dental calcification and chronology of dentition, (Buikstra and Ubelaker, 1994; Ubelaker, 1989; WEA, 1980), the length of the diaphysis in long bones (White & Folkens, 1991; Brothwell, 1981), and the degree of bone ossification (closure of epiphysis and diaphysis) (White & Folkens, 1991; Brothwell, 1981; Scheuer & Black, 2000) were used in order to determine the age at death of subadult individuals.

In this work, the term trauma is explained as the injuries which causes the bone to deform partially or in total. Trauma types are usually listed as fractures, dislocations, bone injuries caused by drilling and cutting tools and fire arms, soft tissue injuries, scalp scraping, amputations, strangulations, decapitations, and trepanations. The evidence of traumatic injuries were examined macroscopically using the methods provided by Lovell 1997 and Waldron 2009 and the Global History of Health handbook (Steckel et al., 2006). Based on these guidelines, all fractures were recorded by type and skeletal element. The location of the injury, shape, color, dimensions and possible complications on the skeletal element used to differentiate premortem, perimorten, and postmortem skeletal injuries. This study focused on injuries on post-cranial bones (including femur, tibia, fibula, humerus, ulna, radius, scapula, clavicle and ribs) and cranium with all major bones (including frontal, parietal, occipital, and maxilla). Adults were classified into three age groups: young adult (18–30 years), middle adult (30–50 years), and old adult (50+ years). The skeletal samples were compared according to chronological period, age and sex.

5. RESULTS

Within the total assemblage of 328 individuals, 13 (3.96%) neonates, 78 (23.78%) infants, 60 (18.29%) children (juveniles included), 75 (22.86%) female adults, 86 (26.21%) male adults were identified, and 16 (4.87%) specimens remained unidentified (Table 1). 46.03 % of the population were within the age group of subadult (Erkman & Surul, 2014). Adults were grouped into one of three age categories (18-30 young adult, 30-50 middle adult and 50+ old adult). The analysis of the Van Castle Mound population revealed the presence of 30 trauma cases (Table 2). Eight different trauma types were observed in 24 individuals: trepanation, post-fractural infection, oblique fractures, comminuted fractures, direct traumas, head deformations, angular fractures, and depression fractures (Fig. 3, Table 3). In total 30 individuals (9.14%), 10 (13.33%) female, 17 (19.76%) male, and 2 (3.33%) children, show trauma cases out of the entire sample. Additionally 60 % of trauma cases were post-cranial and 40 % were cranial (Table 4). The prevalence of trauma in young adults was 6.66 %, in middle adults was 18 %, and in old adults was 7 %.

Five individuals displayed signs of multiple trauma. Cranial injures and post-cranial injures were identified in both sexes. The frequency of trauma was higher in male indiviudals than females. The middle adult age group was exposed to trauma more frequently than the other age groups. This pattern represented in the Van Castle population is commonly found in ancient Anatolian societies.

Table 1: Age and sex distribution of the population at Van Castle Mound.

SEX	N	%	AGE	N	%
Female	75	22.86	**Neonate**	13	3.96
Male	86	26.21	**Infant**	78	23.78
Uncertain Adult	16	4.87	**Children**	60	18.29
			Adult	177	53.96
TOTAL	177		**TOTAL**	328	

Table 2: Trauma types described in the collection

Code	Sex and Religion	Age	Trepanation	Depression Fracture	Comminuted Fracture	Oblique Fracture	Head Deformation	Myositis Ossificans	Direct Trauma	Spiral Fracture	Infection	Angular Fracture
VK602	Female Muslim	50 +		Coronal-Sagittal Suture								
VK216	Female Christian	50 +		Occipital-Left Temporal Parietal								Left Costae
VK114	Female ?	45–50							Frontal, Nasal and Maxilla			
VK144	Female Christian	30–40			Right Humerus							
VK146	Male Christian	50 +				Left Metacarpal II						
VK149	Male Christian	45–50						Right Femur				
VK157	Female Muslim	45–50								Right Fibula	Right Tibia	
VK158	Male Muslim	40–45		Right Tuber Frontale		Right Fibula						
VK225	Male Muslim	40–45		Left Parietal and Right Parietal			Parietal, Temporal and Mastoid Parts					
VK249	Male Christian	40–45				Left Clavicula						Left Costae
VK269	Male Muslim	30–40		Frontal								
VK378	Child Christian	4		Left Parietal								

VK392	Male Christian	60–70							Right Scapula			
VK400	Female ?	?				Phalanx						
VK503	Male ?	?			Left Radius							
VK605	Child Muslim	10–12			Left Femur							
VK023	Male Muslim	45–50				Ulna						
VK89/48	Female Muslim	45–50										Costae
VK89/37	Male Christian	35–40										Costae
VK91/185	Male ?	15–20			Left Humerus							
VK89/13	Male Christian	50–55							Glebella			
VK89/34	Male ?	25–35							Left Parietal			
VK90/149	Female ?	55–60			Radius							
VK90/221	Unknown ?		Frontal									

Table 3: The number of trauma of the population at Van Castle Mound.

	N	n	%
Male	86	17	19.76
Female	75	10	13.33
Children	60	2	3.33
Infant	78	0	0
Neonate	13	0	0
Unknown	16	1	0
Total	**328**	**30**	**9.14**

Table 4: Trauma frequencies of skeletal elements by age group in Van Castel Mound.

ELEMENT	YOUNG ADULT (18-30 YEARS)	MIDDLE ADULT (30-50 YEARS)	OLD ADULT (50+)	UNKNOWN	%
Cranial					
Cranium	1	7	3	1	%40.00
Post-Cranial					
Humerus	1	1			%60.00
Radius			1	1	
Ulna		1			
Scapula			1		
Clavicle		1			
Ribs		3	1		
Femur		2			
Tibia		1			
Fibula		2			
Metacarpal			1		
Phalanx				1	
TOTAL	2 (%6.66)	18 (%60.00)	7 (%23.33)	3 (%10.00)	

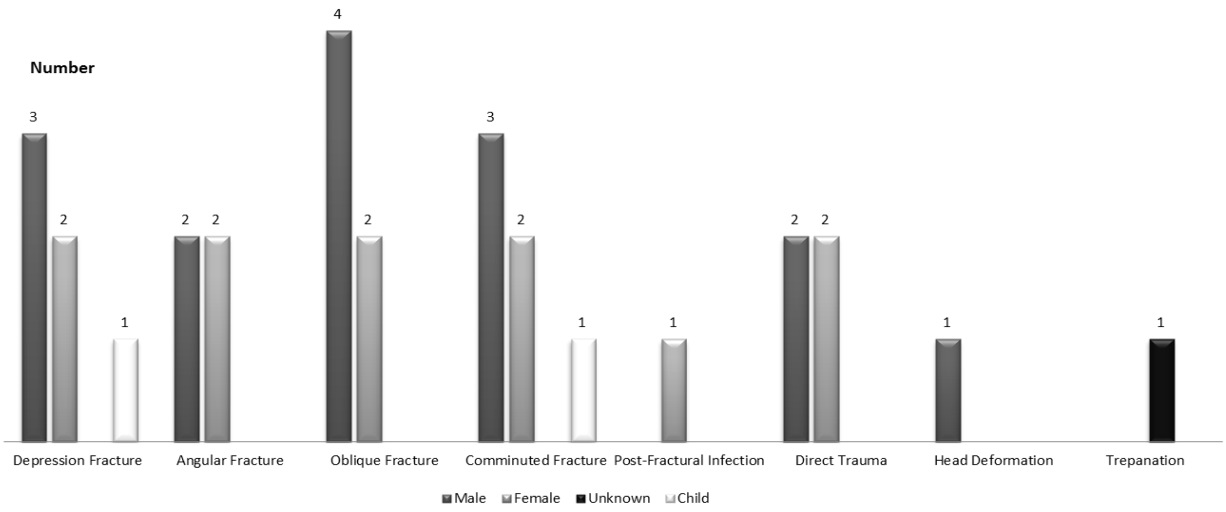

Figure 3: Distribution of trauma types in male, female, child, and unknown individuals.

In the Van Castle Mound population, probably a grooving method lead to a case of trepanation that was observed at the anterior of the coronal suture on the left side of the frontal bone of an adult individual (Van Kalesi 90-221, here after VK). However, it was not possible to measure the trepanation hole since nearly half was missing. The obvious bone neoformation at the circumference of the hole suggests that the operation was successful and the person had survived for some time after the treatment (Figs. 4a, b).

A protrusion assumed to be the result of a trauma was present above the glabella of the cranium of a male aged 50–55 years (VK 89-13, Fig. 5a). A depression was observed on the cranium of a woman aged over 50, at a distance of 0.5 cm where coronal and sagittal sutures are connected. This depression could have been caused by a strong blow from a blunt tool (VK 602, Fig. 5b).

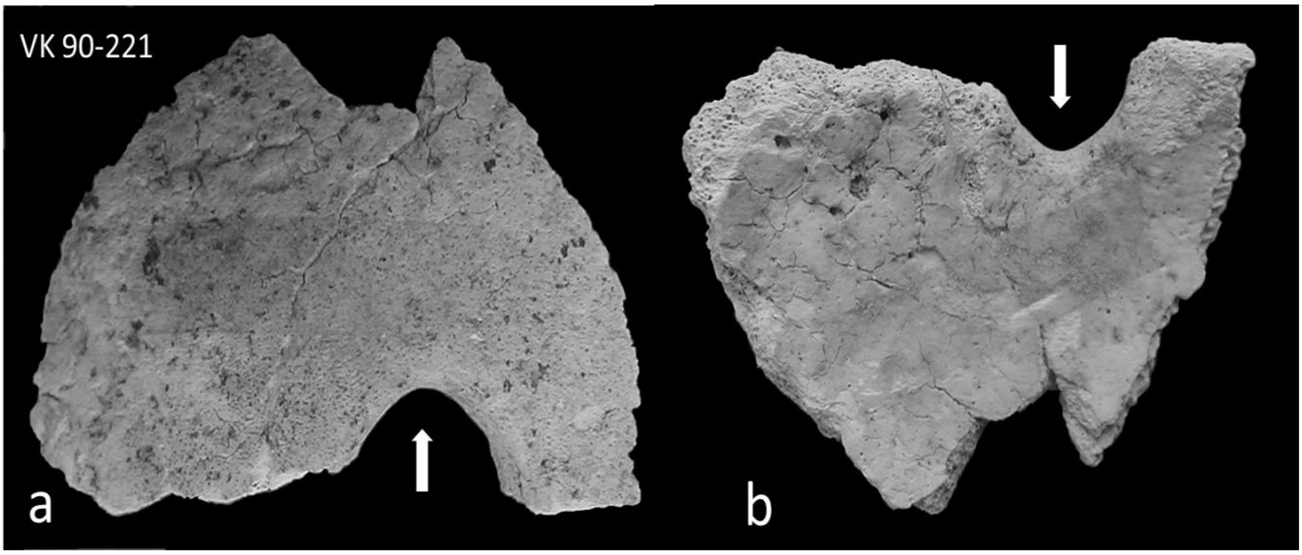

Figure 4: Grooving technique performed on the anterior of a coronal suture of the left frontal bone of an adult individual ("a" from exterior and "b" from interior views).

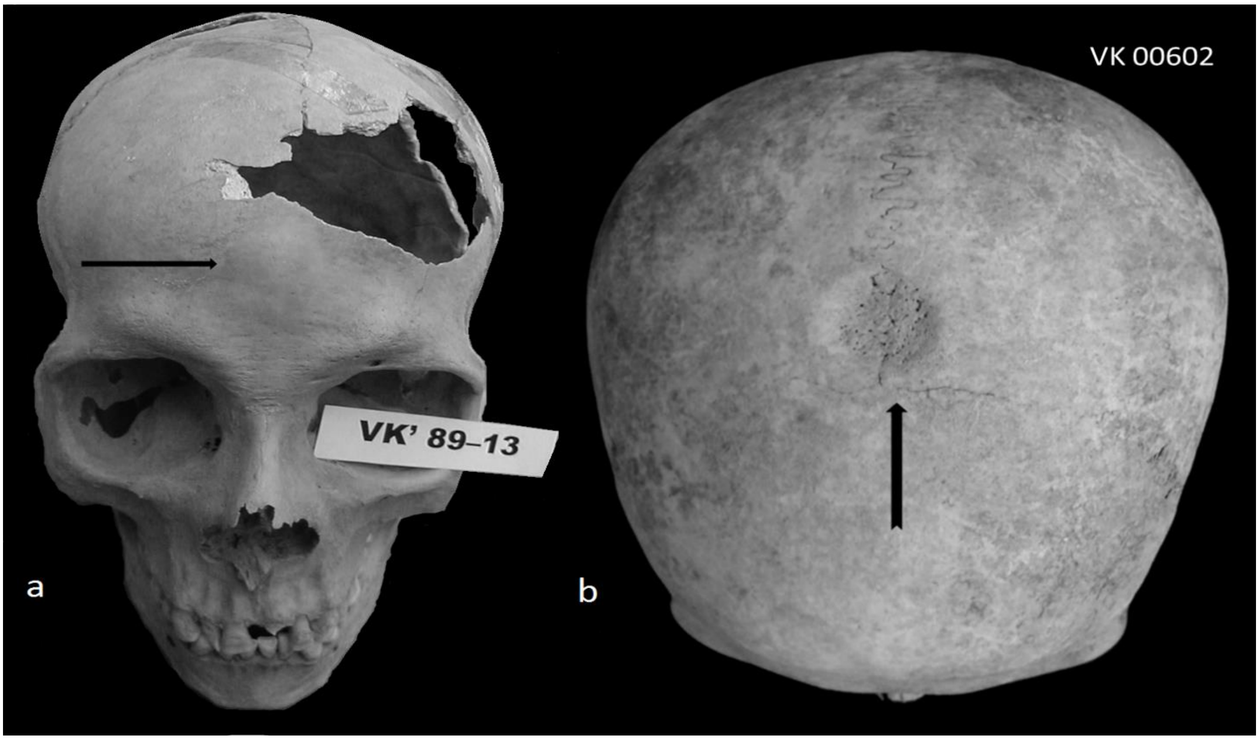

Figure 5: A protrusion assumed to be the result of a trauma was present on the glabella of the cranium of an adult aged 50–55 years (VK 89-13, Figure 7a). A depression was observed on the cranium of a woman aged over 50 years (VK 602), at a distance of 0.5 cm where coronal and sagittal sutures are connected.

It seems that the individual managed to survive the injury, as the fracture shows indications of healing. Two depression fractures on the cranium and a head deformation were observed in a male aged 40–45 years (VK 225, Fig. 6). The cranial depression fracture was located close to the joint between left parietal and occipital and also near the sagittal suture connecting the left parietal to the right one. Examination of the form and structure of the trauma suggests that it was most likely caused by a blunt tool. This traumatic injury shows similarity with the one in example VK 602. A weak cranium deformation was also present in this individual. There was a slight depression starting from the middle of the parietal bones that ran through the temporal bone and whole cranium, including the mastoid part at both sides.

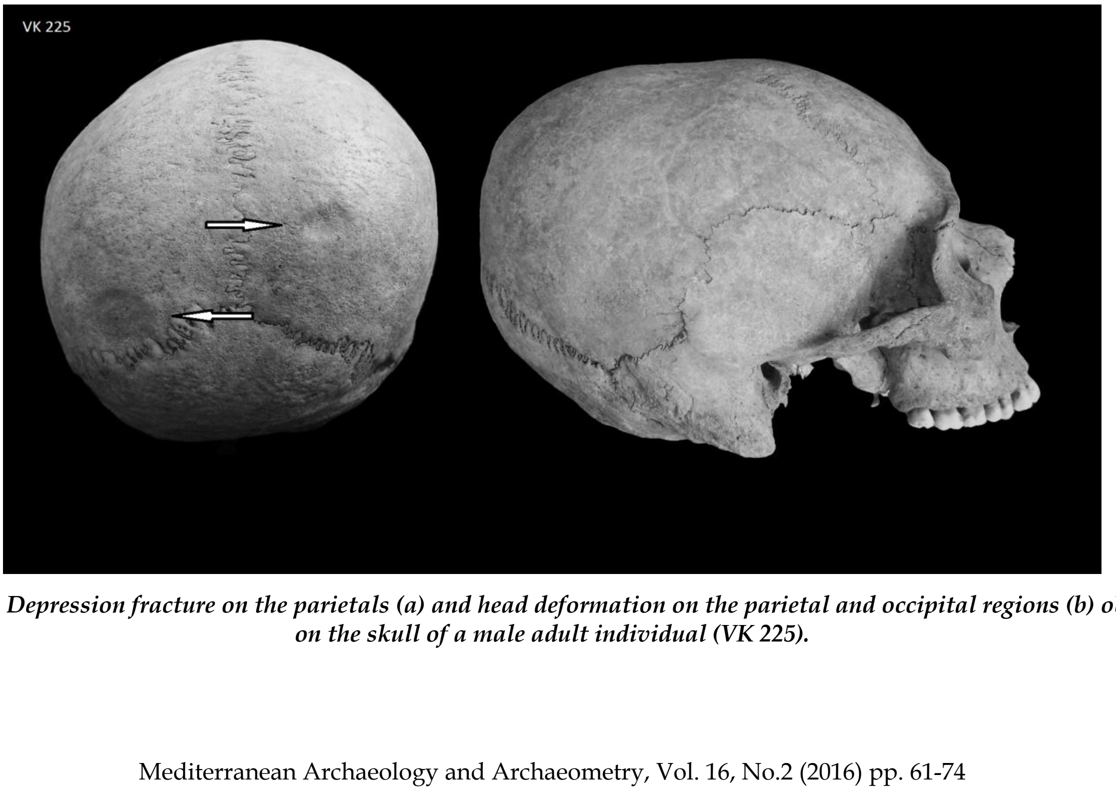

Figure 6: Depression fracture on the parietals (a) and head deformation on the parietal and occipital regions (b) observed on the skull of a male adult individual (VK 225).

Other examples include fractures and fusion on ribs of a male aged 35–40 (VK 89-37, Fig. 7a), additionally, a fused piece of the rib was observed in the same individual (Fig. 7b). A healed rib fracture resulting from a trauma was observed in a female aged 45–50 years (VK 89-48, Fig. 7c). There were angular fractures on the left rib of a male aged 40–45 years (VK 249, Fig. 7d) and a female aged over 55 years (VK 216).

Figure 7: Costae fractures, a and d)- fused costae examples of a male adult individual (VK 89-37, b)- Angular fractures on the left costae of a male adult individual (VK 249, c)- A healed costal fracture after a traumatic injury observed in a female adult individual (VK 89-48).

An oblique clavicular fracture was obseverved in the male aged 35-45 years (VK 249). The analysis of the fracture implies that the trauma was caused by a strong pressure on the left side of the body or a serious accident effecting the left rib and clavicle. To a certain degree this male's injuries healed, albeit not to their original condition, but he managed to survive.

In another case, a fracture resulting from a trauma in the left humerus of a male aged 15–20 years was observed (VK 91-185). The bone had developed to such an extent so as to shelter the fractured upper part of the bone, as displayed in Fig. 8. This type of fracture must have been the result of a very serious accident.

Figure 8: A fracture after a traumatic injury observed in the left humerus of a young male individual (VK 91-185).

Myositis ossificans was identified in the right femur of a male individual aged 45–50 years (VK 149). The lesion initiated at approximately 4 cm below the trochanter minor. In this case there was a bone-like tissue formed in the muscle because the injury was not properly taken care of. Untreatement contusion and hematoma is very common complication in this type of injuries. Probably, this complication must have caused pain and difficulty in standing while working during his life (Fig. 9).

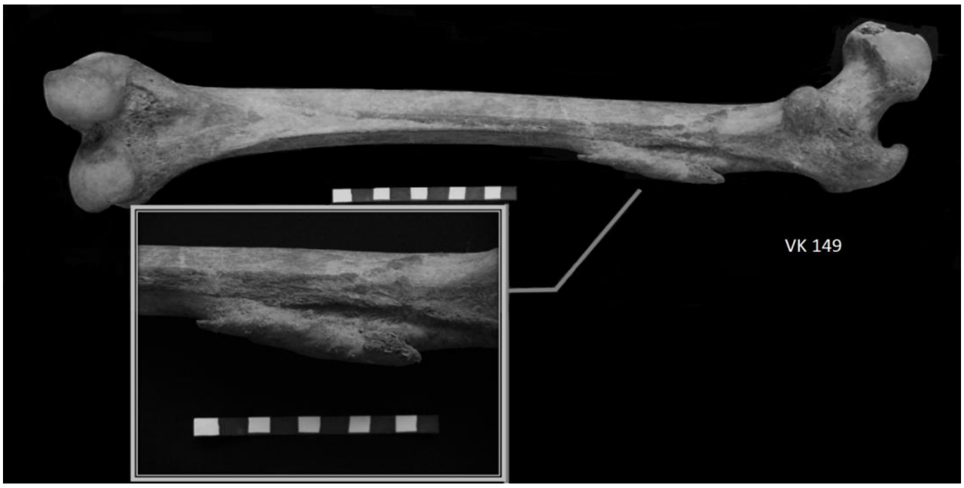

Figure 9: A comminuted fracture observed on the right femur of a male adult individual (VK 149). (Scale bar is 5cm).

Figure 10: Post-fractural infection on the right tibia and oblique fracture on the right fibula are observed on the material of a female adult individual (VK 157).

There was a spiral fracture on the left fibula and tibia of a female individual aged 45–50 years (VK 157). This spiral fracture caused by rapid and aggressive turning of the lower leg while the foot is stationary. The spiral fracture observed on the fibula was probably infected and therefore fused abnormally, resulting in a reduction of the bone length. The spiral fracture of the tibia was also infected, leading to partial deformation of its anatomy (Fig. 10).

In addition to above findings, dental health assessment of individuals indicates the presence of alveolar bone loss with high percentages (47.73% of males and 29.41% of females), antemortem tooth loss (21.93 of males and 14.232% of females), tooth plaque (52.43% of males and 41.33% of females), hypoplasia (21.48 of males and 39.73% of females), dental caries (11.51% of males and 12% of females), and relatively high wear rates (especially in male individuals) among the mature individuals (Gözlük et al., 2003).

6. DISCUSSION

The observed trauma cases comprise 9.14% of the entire sample and were most frequently observed in post-cranial bones (Table 3). Most post-cranial fractures are a result of daily activities and fracture frequencies are more likely to reflect lifestyle (Lovell, 1997). In general, fractures on arms (VK 249) are a typically result of falls onto a shoulder or outstretched arms. They have also been attributed to carrying heavy objects or being kicked by an animal (Waldron, 2009; Agnew et al., 2015). Agriculture and livestock farming could create specialized roles as shepherds, horsemen, and hunters (Agnew et al., 2015). Since the livestock farming was very common in this region, it is believed that some injuries (VK 91-185) was attributed to farming activities with large animals and falls. Most probably, individuals were not able to get medical treatement, however there are signs of healing and person was forced to move his left arm during the his life. Work related cranial fractures are common in agrarian economies, however we can not rule out the possibility of an inter-personal violence (VK 602 and 225) that more oftenly associated with the cranial fractures in the literature (Lovell, 1997; Erkman, 2008). Additionally a slight depression starting from the middle of the parietal bones that ran through the temporal bone and whole cranium, including the mastoid part at both sides of the sample VK 602. We assume that this depression may have resulted from a cultural application of head binding. Since the evidence does not provide sufficient information we decided not to speculate.

The distribution of trauma between the sexes demonstrates that fractures and deformations were found more frequently in males. Males are expected to exhibit higher overall frequencies of trauma, because there is a strong assumption that suggests males tend to get involved in more physically demanding and risky jobs than females (Judd, 2004). It is evident from the specimens labeled VK 157 (Fig. 10) and VK 91-185 (Fig. 8) that some people of the Van Castle Mound had not received proper treatments during healing periods. This condition imposed great harm to the bone and the individual might have had great difficulties during the infection period.

The presence of 30 diverse trauma cases in 328 individuals and their occurrence mainly in individuals aged middle adult (30–50 years) generally points to the presence of a labor-intensive workforce. The bone fractures were often the result of accidents or strong impacts considering the typology of the trauma cases. As can be illustrated from other trauma cases, males of the Van Castle population experienced injuries originating from heavy outdoor work or accidents. The differences in distribution of trauma cases between sexes could depict a labor division in which males were responsible for heavy outdoor activities, while females were responsible for indoor activities in general. This may explain why the males' bones were more prone to trauma than the females' when performing their daily activities in Van Castle society. Generally as in the other Middle Age Anatolian Societies, it is being thought that these traumas are the results of the injuries in doing agricultural practices. Additionally it has been suggested by some previous studies that male individuals may have been more exposed to injuries from various aspects of their life, such as inter-personal conflict, horse riding, hunting, carrying heavy objects, working with large draft animals in agrarian economies (Djuric et al., 2006; Slaus, 2012; Waldron, 2009; Judd & Roberts, 1999; Agnew et al., 2015).

Since the Neolithic time, the practice of trepanation is known in ancient Anatolian societies and it became an increasingly common practice during the Byzantine period in Anatolia (Erdal and Erdal, 2011). In Eastern Anatolia trepanation was observed in four different societies; Van-Karagündüz, Hakkari, Van-Dilkaya Urartu, and Van Castle Mound. However, while the boring and cutting method was the common practice in the first three societies, usage of the grooving trepanation technique was only observed in the Van Castle Mound specimen. In Anatolia, the grooving trepanation technique was performed first in Kurban Hoyuk (~7000 BP) followed by Karatas (2700-2300 BC), Kucukhoyuk (2600-2400 BC), Kultepe (Colony Period), and Gordion (Roman Period) societies (Erdal and Erdal, 2011). Due to its technicality the grooving method was easy to practice, and it was the most frequently used trepanation technique in Europe (Lopez et al., 2011). Spatial and chronological distribution of trepanation techniques is somewhat heterogenous in Anatolia (Erdal and Erdal, 2011). Different trepanation techniques were performed during different time periods in geographically proximate societies. Cranial trauma, tumors, and training were the main purpose of trepanation practice in Anatolian societies. Different arguments propounded to explain the purpose of the trepanations, but solid evidence supporting the magico-therapeutic use is yet to be discovered (Erdal and Erdal, 2011; Zanello et al. 2015).

Prevalence of antemortem tooth loss, alveolar bone loss, tooth plaque, hypoplasia, and dental caries offer clear evidence of a high level of periodontal diseases in Van Castle Mound population. It is widely accepted that archaeological societies showing evidence of high plant carbohydrate consumption also show high rates of periodontal disease and tooth loss (Larsen, 1995; 1999).The combined mortality rate of infants and children (under five years) revealed in our study was high (46.03%) and similar to the rate in less developed countries today. Early termination of lactation in mothers due to insufficient nourishment leads to a decrease in the infant's nutrition, which was one of the most important causes accountable for infant deaths.

7. CONCLUSION

Van Castle Mound population form the medieval time in Anatolia, as expected, show typical characteristics of an agrarian society. Trauma cases and ither archaeological evidences from the site support that our population participated in agricultural activity and heavy labor (Gözlük et al., 2003; Erkman and Surul, 2014; Konyar, 2011). Trauma cases more frequent in male individuals, which suggests that males were more actively involved working in the fields than females in a medieval agrarian society at Van Castle. Agriculture has been identified among the most dangerous occupations at its origin and remains so to this day. Medieval farming would have been no different, and those dangerous repetitive activities increased the potential for injury (Slaus, 2012; Judd and Roberts, 1999; Agnew et al., 2015). The lack of proper treatment of a damaged bone is generally interpreted as that the population suffers from insufficient socioeconomic resources and health services. This phenomenon is seen more clearly in fracture incidents accompanied with infections in some individuals (Figs. 7, 8, 9). However, even though people with trauma were not treated properly, it was not the cause of death. Healing marks in the bones support this conclusion. Additionally, bone neoformation at the circumference of the hole indicate that individual (VK 90-221) with trepanned skull survived for sometime, it seems like the grooving operation was successful (Figs. 4a, b).

On the basis of this, paleopathological evidences of the cranial and post-cranial remains such as porotic hyperostosis, cribra orbitalia, osteophytes, schmorl nodes, osteoarthritis and tuberculosis also from the medieval Van Castle Mound showed that studied population was living under higher physiological stresses, poor living conditions, the farming community with a low socio-economic structure, which is also very indicative of an agricultural population (Gözlük et al., 2003). Approximately 28% of the Van Castle Mound population died before the age of one year (Table 1). Furthermore, as a segment, infants and children in the medieval Van Castle Mound population was the first to experience adverse health conditions and mortality in reaction to environmental and cultural changes that affect the availability and accessibility of food resources (Goodman & Armelagos, 1989).

Consequently, climate change history of Van Castle Mound is well in accord with the data cataloged by Telelis (2005) and Stathakopoulos (2003) and recently updated by McCormik et. al (2012) and Haldon et al., (2014). This historical data indicates repetitive records of severe winter, extreme cold, floods and long years of drought and famine periods between 873 to 1096 AD in eastern Anatolia and Armenia. This time range corralates with the bottom level of the Van Castle mound which is dated 940 to 1020 AD. Upper level of the mound is dated 1800/1940 AD and climate dynamics were very similar today. Considering our findings, we feel comfortable to argue that the Van Castle Mound people were subject to heavy labor and unsafe working conditions to obtain food from sources seasonally and were unable to keep sufficient stores under the influence of erratic and harsh environmental conditions.

ACKNOWLEDGEMENTS

We would like to thank A. H. Kaya for editing the language of the article. We would also like to thank University of Ahi Evran Science Foundation (Grant No. PYO.FEN.4001.14.005, PYO.FEN.4001.12.025 and SBA.11-12) for financial support of field and laboratory research.

REFERENCES

Acsadi, G.Y., Nemeskeri, J. (1970) *History of Human life span and mortality.* Akademia Kiado, Budapest.

Agnew, A. M., Betsinger, T. K., Justus, H.M. (2015). Post-Cranial Traumatic Injury Patterns in Two Medieval Polish Populations: The Effects of Lifestyle Differences, PLoS One., Jun 11;10(6).

Bass, W. M. (1979) *Human osteology: a laboratory and field manual of the human skeleton,* Missouri Archaeological Society, Cornell University Press.

Belli, O. (1975) Doğu Anadolu'da Yeni Arkeolojik Keşifler: Yedisalkım (Put) Köyü Boyalı Mağara Resimleri, *Tarih Dergisi,* 28–29, 1–40, İstanbul.

Brooks, ST and Suchey, JM. (1990) Skeletal age determination based on the os pubis: A comparison of the AcsadiNemeskéri and Suchey-Brooks methods, *Human Evolution,* 5, 227–238.

Brothwell, D.R. (1981) *Digging Up Bones.* 3. Press, Cornell University Press.

Buikstra, J. E., and Ubelaker, D. H. (1994) *Standards for Data Collection from Human Skeletal Remains.* Research Series, no. 44. Arkansas Archaeological Survey, Fayetteville.

Demir, A. (2004) *İslâm'ın Anadolu'ya Gelişi*, Kent Yayınları, İstanbul.

Djuric, M.P., Roberts C.A., Rakocevic Z.B., DjonicD.D., LesicA.R.(2006). Fractures in LateMedieval skeletal populations from Serbia, *Am J Phys Anthropol.*, 130,167–178.

Erdal Y.S. and Erdal Ö.D. (2011) A review of trepanations in Anatolia with new cases, *International Journal of Osteoarchaeology, 21(5),505-534.*

Erdal YS, Erdal ÖD. 2012. Organized Violence in Anatolia: A Retrospective Research on the Injuries from the Neolithic to Early Bronze Age. International Journal of Paleopathology 2: 78– 92.

Erkman, A.C. (2008) Van Dilkaya Erken Demir Çağı Ve Orta Çağ Toplumunda Ağız ve Diş Sağlığı, Ankara Üniversitesi Sosyal Bilimler Enstitüsü, Basılmamış Doktora Tezi, Ankara.

Erkman, A.C., Surul Ö. (2014) Van Kalesi Höyüğü (Ortaçağ) insanlarının travma ızleri analizi, *Ankara Univ. Sos. Bil. Der,* 5(2), 118–135.

Erzen, A. (1992) *Doğu Anadolu ve Urartular*, TTK Yayınları., Ankara.

Çilingiroğlu, A. (1988) *The History of the Kingdom of Van Urartu*, İzmir.

Gülec E. (1988) Van Dilkaya'da iki beyin ameliyati vakasi, *IV. Arkeometri Sonuclari Toplantisi,* 153-61, Ankara.

Goodman, A.H., Armelagos, G.J. (1989) Infant and childhood morbidity and mortality risks in archaeological populations, *World Archaeology*, 21(2), 225–243.

Gözlük, P., Yiğit, A., Erkman, A.C. (2003) Van Kalesi Eski Van şehri insanlarındaki sağlık sorunları, *Ark. Son. Top.,* 19, 51–62.

Haldon, J., Roberts N., Izdebski A., Fleitmann D., McCormick, M. Cassis M., Doonan O., Eastwood W., Elton H., Ladstätter S., Manning S., Newhard J., Nichol K., Telelis I., Xoplaki E. 2014. The climate and environment of Byzantine Anatolia: integrating science, history and archaeology J. Interdiscip. Hist., xlv (2) (2014), pp. 113–161.

Hillson, S. (1996) *Dental Anthropology.* Cambridge University Press, New York.

İşcan M.Y., Loth SR., Wright RK. (1984) Age Estimation Fromt He Ribby Phase Analysis: White Males. *Journal Of Forensicscience, 29*, 1094-1104.

İşcan, M.Y., Loth S.R., Wright R.K. (1985) Age Estimation From The Ribby Phase Analysis: White Females. *Journal Of Forensicscience, 30*, 863.

Judd, M.A. (2004) Traumain the city of Kerma: Ancient versus modern injury patterns, *Int. J.Osteoarchaeol., 14*, 34- 51.

Judd, M.A. ve Roberts, C.A. (1999) Fracture trauma in a medieval British farming village, *Am. J. Phys. Anthropol., 109*, 229-243.

Kaden, H., Peters, F., Lorke, A., Kipfer, R., Tomonaga, Y., Karabiyikoglu, M., 2010. The impact of lake level changes on deep-water renewal and oxic conditions in deep saline Lake Van, Turkey. Water Resour. Res. 64.

Karaca, Y. (1996) Van ve Çevresindeki Manastır Kiliseleri, Yüzüncü Yıl Üniversitesi Sosyal Bilimler Enstitüsü Basılmamış Yüksek Lisans Tezi, Van.

Kempe, S., Kazmierczak, J., Landmann, G., Konuk, T., Reimer, A., Lipp, A. (1991) Largest known microbalities discovered in Lake Van, Turkey. Nature, 349, 605 – 608.

Kılıç, S., Saruhan, M., Tatlı, S. (2006*) Van İli Üzerine Genel Bilgiler*, Van 2006 Kültür ve Turizm Envanteri , İstanbul.

Konyar, E. (2011) Van-Tuspa aşağı yerleşmesi-Van Kalesi Höyüğü Kazıları,. *33. Kazı Son. Top,.* 3, 409–428.

Landman, G., Reimer, A., Lemcke, G., Kempe., S. (1996) Dating late Glacial abrubt climate changes in the 14, 570 yr long continuous varve record of Lake Van, Turkey. Palaeogeography, Palaeoclimatology, Palaeoecology 122, 107–118.

Larsen, C.S. (1995) Biological changes in human populations with agriculture, *Annu. Rev. Anthropol*., 24, 185–213.

Larsen, C.S. (1999) Bioarchaeology; Interpreting Behavior from the Human Skeleton, Cambridge University Press.

Lopez, B., Caro, L., Pardinas, A.F. (2011) Evidence of trepanation in Medieval population (13th-14th century) of northern Spain (Gormaz, Soria). Anthropological Science 119, 247 – 257.

Lovejoy, CO, RS Meindl, TR Pryzbeck, and RP Mensforth. (1985) Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age at death, *Am J Phys. Anthropol.,*68(1):15-28.

Lovell, N.C. (1997) Trauma analysis in paleopathology. *Yearbook of Physical Anthropol*., 40, 139–170.

McCormick M, Büntgen U, Cane MA, Cook, E.D., Harper, K., Huybers, P., Litt, T., Manning, S.W., Mayewski P.A., More, A.F.M., N, K., Tegel, W. (2012) Climate change during and after the Roman Empire: Reconstructing the past from scientific and historical evidence. The Journal of Interdisciplinary History 43(2): 169–220.

Mangaltepe, İ. (2005). XIX. Yüzyıl Fransız Seyyahlarına Göre Van. Yayımlanmamış Doktora Tezi, İstanbul, İstanbul Üniversitesi Sosyal Bilimler Enstitüsü.

McKern, TW and Stewart, TW. (1957) Skeletal Age Changes in Young American Males Analysed from the Standpoint of Age Identification Environmental Protection Research Division (Quartermaster Research and Development Centre, US Army, Natick, MA), *Technical Report* No EP-45.

Meindl, RS and Lovejoy, CO. (1985) Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral-anterior suture, *American Journal of Physical Anthropology,* 68, 57–66.

Olivier, G. (1969*) Practical anthropology*. Charles C. Thomas Publisher, Springfield, Illionis.

Ortner, D.J. (2003) *Identification of pathological conditions in human skeletal remains*, second ed. Academic Press.

Ortner, D.J., Putschar, W.G.J. (1985) Identification of pathological conditions in human skeletal remains, *Smithsonian Contributions to Anthropology,* 28, 1–488.

Ostrogorsky, G. (1995) *Bizans Devleti Tarihi*, TTK, Ankara.

Roberts, C., Manchester K. (1995) *The Archaelogy of Diseasa,* Cornell University Press, Ithaca New York.

Scheuer, L and Black, S. (2000) *Developmental Juvenile Osteology,* Academic Press, London.

Slaus, M., Novak, M., Bedic, Z., Strinovic, D. (2012) Bone Fractures as Indicators of Intentional Violence inthe Eastern Adriatic From the Antique to the LateMedieval Period (2nd–16th Century AD), *Amerıcan Journal of Physıcal Anthropology*, 149, 26–38.

Stathakopoulos, D. (2004) *Famine and Pestilence in the Late Roman and Early Byzantine Empire. A Systematic Survey of Subsistence Crises and Epidemics (Birmingham Byzantine and Ottoman Monographs 9)*, Aldershot.

Steckel RH, Larsen CS, Sciulli PW, Walker PL. (2006) The Global History of Health Project: data Collection Codebook, Ohio State University, Columbus, OH.

Tarhan, M. (1989) 1987 yılı Van Kalesi ve Eski Van Şehri Kazıları, *10. Kazı Son. Top.,* 1, 369–428.

Tarhan, M., Sevin, V. (1991) Van Kalesi Ve Eski Van Sehri Kazilari, *12. Kazı Son. Top*. 2, 429–456.

Telelis, I. (2005) Historical-climatological Information from the Time of the Byzantine Empire (4th-15th Centuries AD), *History of Meteorology,* 2, 41-50.

Todd, T. W. (1920) Age Changes in the Pubic Bone, I: The Male White Pubis. *American Journal of Physical Anthropology,* 3:285–334.

Turan, O. (1993) *Doğu Anadolu Türk Devletleri Tarihi*, 3.Baskı, Boğaziçi Yayınları, İstanbul.

Turan, O. (1996) *Selçuklular Tarihi ve Türk-İslam Medeniyeti*, 5.Baskı, Boğaziçi Yayınları, İstanbul.

Ubelaker, D.H. (1989) *Human skeletal remains: Excavation, analysis, interpretation*, Washington. Smithsonian Institution Press.

Waldron, T. (2009) *Palaeopathology*. Cambridge University Press.

White, T.D., Folkens, P.A. (1991) *Human Osteology,* Academic Press, San Diego.

Workshop of European Anthropologist. (1980) Recommandations for age and sex diagnoses of skeletons, *Journal of Human Evolution,* 9(7): 518- 549.

Zanello, M., Decofour, M., Corns, R., Pallud, J., Charlier, P. (2015) Report of a successful human trepanation from the Dark Ages of neurosurgery in Europe, *Acta Neurochirurgica*, 157(2), 303–304.